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Edited by

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THE TEA RESEARCH INSTITUTE

St. Coombs, Talawakelle.

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EDITORIAL

FERTILISER DISTRIBUTION

In spite of the severe hold-up caused by the floods, and the consequent interruption in railway transport, it is now hoped that all of the 1947 fourth quarter manure will have been distributed by the end of January 1948, only one month later than the normal schedule. Deliveries of 1948 first quarter tea manure will then commence immediately and, as the railway authorities are giving every assistance in the way of wagons, there is no reason to anticipate any further delay in distribution.

It is realised that considerable inconvenience has been caused to estates, but it is hoped it will also be appreciated that every effort has been made by the Fertiliser Control Bureau to reduce delays to a minimum.

Tea and Rubber manure permits for 1948 have already been issued to estates and it may be as well perhaps to call attention once more to the new tea mixture, T. 370, which is made up as follows :—

MIXTURE T. 370

	lb.	Nitrogen	Phosphoric acid	Potash
Sulphate of ammonia	220	45.32	—	—
Mineral Phosphate	110	—	32.45	—
Muriate of potash	40	—	—	24.0
	370	45.32	32.45	24.0

Tea estates will receive the same *nitrogen* allowance per acre as in 1947 but the proportions of phosphoric acid and potash have been materially increased in the new mixture.

GREEN MANURES

It is noticeable that, on a great many estates, green manures are now much less in evidence than a few years ago. This is particularly unfortunate as with artificial manures in short supply, and likely to remain so for sometime, green manures offer the cheapest and most effective method of maintaining and building up soil fertility generally. From many districts reports are being received of thin, run-out areas. The shortages of fertilisers and the incidence of Blister Blight have, no doubt, both contributed to this effect but the time is now overdue when every effort should be made to ameliorate this condition of affairs by the widest possible use of green manures.

BLISTER BLIGHT

The very light North-East Monsoon experienced in most areas has again acted as a check on Blister Blight and reduced attacks to a level considerably below what might have been expected. With the normal dry weather in front of us this condition of affairs will, it is hoped, continue. It would be unwise, however, to assume that in 1948 weather conditions in general will be as favourable, from the Blister Blight aspect, as those experienced in 1947 and no atmos-

phere of complacency in regard to this disease should be encouraged.

Superintendents should now, as a result of the numerous articles published during the year in the *Tea Quarterly,* and lectures and discussions held at meetings of District Planters' Associations, be in a good position to carry out the various protective measures advocated by the Institute.

In the present issue Blister Blight is dealt with from a different aspect in an article by Dr. Tubbs dealing with the use of sprays and dusts.

To assist superintendents in refreshing their knowledge in regard to Blister Blight generally, a special short index of articles and notes issued by the Tea Research Institute in connection with the disease is being sent out. It is hoped full use will be made of this, as it is unfortunately true to say that a very large number of enquiries are received which are actually quite unnecessary in that the subjects of enquiry have already been fully explained in quite recent issues of the *Tea Quarterly.*

With the return of Dr. Gadd at the end of January, Dr. Tubbs' immediate responsibility in connection with Blister Blight will be considerably curtailed and he will be able to devote himself more freely to his own particular subjects of tea selection and propagation. This seems, therefore, an appropriate time to acknowledge the enormous amount of arduous and successful work carried out by Dr. Tubbs during the past year in dealing with this pest. We feel sure that tea planters throughout the Island gratefully acknowledge the important services he has rendered to the Industry.

SPRAYING AND DUSTING IN THE CONTROL OF BLISTER BLIGHT OF TEA

F. R. TUBBS

I.—INTRODUCTION

Fungicides, applied either by spraying or by dusting, play an important part in the control of the majority of fungal diseases. It is possible that Blister Blight may prove to be no exception, but three major difficulties require consideration in any plan for the wide-spread use of fungicides as a means of adding to that degree of control obtainable by the modification of the methods and timings of cultural operations. These are: firstly, the difficulties arising from the hilly terrain of the tea districts of Ceylon; secondly, the cost factor; thirdly, the need to avoid the slightest risk of affecting the manufacturing qualities of the crop harvested. The importance of these factors is enhanced by the need for repeated treatment if adequate protection is to be obtained by spraying or dusting. The fungus is unaffected by applied chemicals when within the host tissues, and thus protection of the tea is dependent upon the prevention of infection. Since the majority of infections occur either upon the outermost of the embryo leaves forming the shoot-bud, or upon the first or second leaves, it follows that the protection afforded by any single applica-

cation is vitiated as new leaves unfold and expose their expanding and unprotected tissues to form a new and vulnerable leaf surface. Further, the increasing resistance of the earlier formed leaves renders the fungicide upon their surfaces finally redundant. The need for thorough, as well as repeated, treatment follows from the fact that infection can occur on both sides of the leaf and independently of the stomata, contrary to the statements in the early literature of the disease.

The steep hill faces on which tea is grown in Ceylon and the wide spaces between the narrow paths at present preclude any form of sprayer which cannot be taken up and down the narrow rows between the bushes and over the drains and rocks encountered. It is for this reason, together with the ease with which the spray can be placed on the young growth of individual bushes, that the knapsack sprayer has up till now been generally used in Ceylon. But since one such sprayer will treat only about 1-1½ acres a day, (or up to 3 acres if relays of spraying coolies are used) and since frequent sprayings are of great importance, the need arises for numerous sprayers if any large acreage of mature tea is to be protected. The use of motor borne sprayers of types at present available is precluded by the nature of the ground. Any machine involving generalised distribution of spray material in the form of fog or mist must surmount the wastage resulting, firstly, from indiscriminate treatment of soil, green manures and mature tea foliage in addition to the superficial immature growth and secondly, from the tea close to the generator being given excessive doses in order to ensure that the tea at the maximum distance received an adequate amount. At present, therefore, the terrain enforces outlay on numerous small sprayers together with an accompanying high labour requirement. These general considerations also apply, in varying degree, to the use of dusting machines.

While the cost of the spray material applied in an individual application may be low, the need for regular and frequent treatment is unlikely to allow of the spraying of bearing tea ever becoming an economic proposition. The protection of pruned tea during the recovery period before tipping falls into rather a different category, which must be considered in relation to the policy of pruning "for dry weather recovery from budbreak onwards" which has been recommended. The recommendation for estates suffering from blister blight to prune in December and January in the 'South-Western' zone receiving both monsoons, and in May and June in the zones receiving their main rainfall in the North-East Monsoon is normally feasible provided pruning gangs are materially increased. Nevertheless, the unbalancing of monthly crops and the labour problems that arise as a result render it desirable to extend the pruning period if possible. Since it is very desirable that a more complete plucking table should have been produced by the time the rainy season arrives than is present on a freshly 'tipped' bush, pruning later than the periods suggested is inadvisable. But the risks involved in pruning during late October or November in Dimbula, or during April in Uva, could however be met by artificially protecting the early recovery growth from blister blight. Tipping, and the full development of the plucking table thereafter, could then take place in the ensuing dry weather. Where the period between budbreak and tipping is materially lengthened by the slow growth experienced at high elevations, as in the Nuwara Eliya district, this possibility is of particular interest, since the normal annual period of dry weather

is too short to allow of complete recovery taking place within it.

The third factor can be briefly dealt with. No fungicide is at present known whose use on tea in plucking can be unequivocally recommended as free from any possibility of affecting the manufacture of the crop. There is, therefore, at present a necessary restriction of spraying and dusting to young tea and to mature tea not in plucking.

Nevertheless, this still allows of a wide field of usefulness and in the following sections the application of sprays and dusts, and their relative usefulness, will be discussed in greater detail.

II—FUNGICIDES

Preliminary tests of the efficacy of different fungicides in protecting tea from blister blight were commenced at St. Coombs with the arrival of the pre-monsoon rains in April-May, 1947, when field conditions first allowed of a material increase in the frequency of the disease. At the time of writing (November), the untreated tea in the field in which the majority of the experiments were carried out is only just beginning to achieve a reasonable cover of leaf, after having been relatively lightly pruned in April. In all experiments a period of three weeks was allowed to elapse between the initial treatment and the first recordings, in order to allow for the "incubation period" of the fungus within the host tissues.

The first trial involved the comparison of the effects of dusting with sulphur and with a proprietary 'Bordeaux' powder containing copper prepared by Tomlinson & Hayward Ltd., of Lincoln, and of spraying with the proprietary copper fungicide 'Perenox' at the strength of 4 oz. in 10 gallons of water. These treatments were repeated weekly in one series, and fortnightly in the other. Blisters were removed and counted weekly, a total of 27,301 blisters being dealt with in 17 collections between 24th May, and the 13th September, 1947. These were distributed among the treatments as shown in Table I.

TABLE I.

	Weekly	Fortnightly
Control, untreated	6,920	6,480
Sulphur, dusted	4,031	5,597
'Bordeaux' dusted	938	2,011
Perenox, sprayed	245	1,079
Totals	12,134	15,167

These results illustrate the efficacy of copper fungicides in the case of this disease, and also the advantage resulting from frequent treatment.

At an early stage in the progress of this experiment, it was apparent that sulphur dusting gave little promise of providing an effective protection against the disease. This conclusion was supported by the results obtained from experiments involving the direct comparison of sulphur dusted and untreated bushes on several estates, including St. Coombs. In the latter case, the comparison was carried out for a period of eleven weeks. The mean infestation based upon a total of some twelve thousand blisters was :—

Sulphur dusted — 7.8 blisters per bush per week.

Control — 8.0 blisters per bush per week.

The sulphur was applied weekly at a rate of approximately ten pounds per acre. Dusting was confined to the plucking table and no attempt was made to treat the whole of the bush. Although the treated plots gave off a sulphurous odour detectable at a considerable distance, there was no evidence of 'action at a distance' such as has rendered

sulphur dusting particularly efficacious in the case of those fungi, *e.g.*, the mildews, which are very susceptible to sulphur compounds.

Sulphur in the form of lime-sulphur was found to be more effective, however, and I am indebted to Dr. Padwick, of Imperial Chemical Industries (India) Ltd., for the suggestion that its efficacy would be still further increased by high pressure spraying. The lime-sulphur, in the form of 'Sulphinette' obtained locally, was used at a strength of 1 in 40 and at a rate equivalent to 120 gallons per acre, applied as a fine spray after the addition of a 'spreader.' Leaf scorch occurred on the young leaf in some cases, but not to any important extent. The total numbers of leaf blisters and of stem blisters collected from the three series of plots are shown in Table II.

germination of the fungal spores. However, experiments to determine the effects of spraying with lime suspensions of varying concentrations, and of spraying leaves with sodium phosphate solutions of different acidities gave negative results, as detailed below.

The lime experiment involved the comparison of Perenox, applied at the rate of 4 oz. in 10 gallons, with 4 per cent, 2 per cent and 1 per cent suspensions of calcium hydroxide in water sprayed on to the young growth on pruned tea, the first application being made immediately budbreak was observed. The rate of application in the latter stages lay between 80 and 100 gallons per acre, owing to particular care being taken to ensure that all young shoots were heavily coated. The numbers of blisters collected were as shown in Table III.

TABLE II

	Leaf blisters. (In eleven weeks)	Stem blisters (In three weeks)
Control ...	1,818	2
Sulphinette Weekly ...	338	7
Sulphinette Fortnightly ...	660	25

TABLE III

	Leaf blisters (In eight weeks)	Stem blisters (In three weeks)
Control ...	7,810	412
Perenox ...	298	5
Lime 1 per cent ...	9,042	372
Lime 2 per cent ...	7,744	278
Lime 4 per cent ...	7,761	295

The greater efficiency of the lime-sulphur in relation to sulphur dust raises the question whether the alkaline nature of the lime-sulphur deposit was influencing

As before, Perenox treatment was effective in markedly reducing the degree of infection, but the application of an alkaline coating was quite ineffective.

In the comparison of the effects of spraying the young leaves and buds with strongly buffered solutions of differing acidity, the solutions used were :—

A.—Sodium dihydrogen phosphate ($Na\,H_2\,PO_4\,2H_2O$) 10 gm. per litre — pH 3.8

B.—Distilled water — pH 7.0

C.—Sodium phosphate ($Na_3\,PO_4\,12\,H_2O$) 24.4 gm. per litre — pH > 10.

The solutions were sprayed on the young shoots, in the form of a fine mist, at the rate of 23 ml. per bush, twice weekly. The number of leaf blisters removed over a period of nine weeks was as follows, the observed differences not being significant :—

Treatment A	...	13,674
Treatment B	...	15,713
Treatment C	...	12,999

These two experiments sufficed to indicate that control was unlikely to be obtained through efforts to render the acidity in vicinity of the germinating spore unsuitable for its effective growth.

It became apparent early in the progress of the first experiment described that, of the fungicides tested, the most promising were dusts and sprays containing copper. Two further field experiments of more elaborate design were therefore set up without awaiting the completion of the experiments referred to above. The first allowed of comparison of two proprietory fungicidal dusts containing copper with Perenox spray while the second compared the effects of varying the concentration of Perenox. A further variable — that of interval between successive treatments — was also investigated in both experiments. They were laid down on tea clean pruned in April 1947, on which budbreak had just commenced. At this time little evidence existed as to the degree of variation to be expected between similarly treated plots, and therefore no guide was available as to the plot size or replication necessary for reasonably accurate comparison. In the result, the errors proved to be very high, but not high enough to prevent useful conclusions being drawn. Still further experiments with enhanced replication, were subsequently laid down to test under field conditions the effect of the addition of a 'fixative' to the spray fluid and also to compare further fungicidal dusts and spraying material as supplies became available.

The results of these experiments are discussed in the succeeding sections.

III—FUNGICIDAL DUSTS CONTAINING COPPER

The experiment designed to test the efficiency of copper dusts involved the comparison of Perelan I, a product supplied by Imperial Chemical Industries (India) Ltd., Colombo, and of "Colloidal Copper Dust," a product of Messrs. Strawson Ltd., supplied by Messrs. Brown & Co., Ltd., Colombo. These two fungicides were applied at rates of 15 lb. per acre and 30 per acre ; weekly, fortnightly and monthly applications were tested at each rate. The experiment consisted of five randomised blocks each of three plots, each of six sub-plots, each of eight bushes, the plots being allocated to time treatments and the sub-plots to fungicides. The latter included, for comparative purposes, sub-plots allocated to nil treatment (control) and to Perenox applied at the rate of 70 gallons per acre, and a strength of 4 oz. in 10 gallons. Leaf blisters were removed weekly, with as little damage to the rest of the leaf as possible. Towards

the end of the experiment, which continued for fourteen weeks through the South-West Monsoon, records were made of the occurrence of stem lesions while finally the opportunity was taken to collect data on the amount of new ('recovery') growth made after pruning. The results are set out in Table IV.

Dusting significantly reduces the number of infections provided the treatment interval is sufficiently short (Section A). Application at the rate of 15 lb. of dust per acre, while effecting a considerable reduction in the number of leaf blisters, did not produce as good results as treatment at the rate of 30 lb. an acre. At the latter rate Perelan I, applied weekly, did not vary significantly in effect from spraying with Perenox. On the whole, however, Perenox gave the better results save when the time interval between treatments was so great that effective control of the disease was lost. At the rate of 30 lb. an acre Perelan I gave just significantly better results than "Colloidal Copper Dust" but no significant difference was detected at the 15 lb. level. It is a matter of interest that the dusts, in this experiment, were more efficient, relative to Perenox, in preventing stem blisters than leaf blisters (Section B). The high errors associated with the observations render it desirable that this subject should receive further investigation, in order to determine whether stem infections in nurseries, from which the major damage results, can be adequately reduced at an economic cost by light, but frequent applications of a fungicidal dust.

Sections C ; D and E of Table IV provide data upon the amount of growth present on the bushes at the end of the experiment, by which time the bushes were in full plucking. The application of fungicides markedly improved the degree of recovery from pruning, provided the interval between applications did not exceed a fortnight. The differences in effectiveness of the various fungicides were small, and far outweighed by the effects of more frequent treatment.

In those plots on which the ravages of blister blight were reduced to relatively negligible proportions, the ratio of new leaf to new stem was 2.59 (Section F). In unprotected bushes the mean ratio was only 1.04, indicative of the considerable proportion of leaf lost by premature abscission following upon stem infections on or near the axillary bud and leaf infections on or near the petiole, and also by reduction of leaf area through severe infection. The effect was somewhat exaggerated by the difficulty of removing blisters during the course of the experiment without loss of some additional leaf tissue, but field experience confirms that it is nevertheless a very real one. With weekly application, all four dusting treatments were equally effective in reducing such defoliation, but were significantly inferior to the Perenox spray. With a larger interval between successive applications, the latter distinction vanished.

The effects of the observed differences in 'recovery' growth upon infection are discussed in Section IV.

A further comparison of commercial fungicidal dusts was carried out during the North-East Monsoon. Over a period of seven weeks, when infection was relatively light, control plots gave a total of 6·377 blisters per 54 bushes. The results obtained on the treated plots were :—

Approximate rate per acre		15 lb.	30 lb
Perelan I	...	1366	1086
Folosan	...	4342	2990
Sandoz Dust	...	1352	675

TABLE IV

Comparison of effects of copper spray and copper dusts on recovery of tea pruned 27th April, 1947

Section	Measurement	TREATMENT							TREATMENT INTERVAL	
		Treatment interval in weeks	Control	Perelan I Dust 15 lb. per acre	Strawson Dust 15 lb. per acre	Perelan I Dust 30 lb. per acre	Strawson Dust 30 lb. per acre	Perenox 4 oz. in 10 gallons	Sig. diff.	Totals	Sig. diff.
A	Total leaf blisters recorded from totals of 35 bushes during 14 weekly collections from 11-6-47 to 9-9-47 inclusive.	1	11,369*	4,110	5,006	1,580	3,116	952	1,516	14,764	13,367
		2	11 903	11,648	8,918	7 710	11,568	4,880	3,075	44,724	
		4	12,973	12,109	11,682	11,935	13,243	10,322	—	59,291	
B	Total stem lesions recorded from totals of 35 bushes during 3 weekly collections from 9-7-47. to 23-7-47	1	119*	8	29	4	7	3	—	51	—
		2	85	29	40	41	30	12	—	152	
		4	84	107	113	128	85	81	—	514	
C	Total dry weight of new growth (stems & leaves) present below the plucking table 21 weeks from pruning in grammes per 35 bushes.	1	1,230*	4,889	3,647	3,516	3,563	4,160	—	19,775	3,171
		2	1,115*	2,107	2,035	2,653	3,215	3 799	1,051	13,809	
		4	1,088	1,508	1,394	1,508	1,658	1,862	—	7,930	
D	Dry weight of new stems present below the plucking table 21 weeks after pruning, in grammes per 35 bushes.	1	574*	1 550	1,249	1,123	1,219	1,228	—	6,639	463
		2	532*	847	776	996	1,219	1,313	349	5,151	
		4	559	650	658	684	691	747	—	3,430	
E	Dry weight of new leaves present below the plucking table 21 weeks after pruning, in grammes per 35 bushes.	1	656*	3,339	2,398	2,393	2,344	2,932	—	13,406	2,149
		2	583*	1,260	1 259	1,657	1,996	2,486	717	8,658	
		4	529	858	736	824	967	1,115	311	4,500	
F	Ratio $\frac{\text{New leaf}}{\text{New stem}}$	1	1·13*	2·16	1·95	2·14	1·91	2·59	0·39	10·75	1·28
		2	1·05*	1·50	1·66	1·70	1·67	1·85	—	8·36	
		4	0·94	1·30	1·13	1·14	1·45	1·48	0·32	6·50	

NOTES.—The data for the comparison of the effects of the different treatments have been analysed separately for each treatment interval.

Where no value "Significant Difference" is given the treatments have not varied significantly in their effects save as noted below. Values of the "Significant Difference" shown have been calculated after omission of the data for those treatments whose effects are undoubtedly significant and far outweigh the remaining treatment effects. (see Cochran, *Empire. J. Exptl. Agric.*, 1938, **VI**, 157-175). Values omitted for this purpose are marked with an asterisk to indicate that they vary significantly from the remaining values. The "Spray Interval" totals do not include the values for the "Control" plots.

Experiment has thus shown that dusting with copper dusts is capable of giving a fairly high degree of control of blister blight, although in some respects spraying gave rather better results than dusting. The choice of fungicide and also the choice between dusting and spraying will depend in practice upon the cost of obtaining equivalent degrees of protection. The prices of the various fungicides on the Colombo market vary, but the dusts in general have a relatively high landed cost owing to their bulk. On a basis of 30 lb. per acre per treatment dusts compare badly with sprays using about 1½ lb. per acre. They further suffer from the difficulty of concentrating treatment upon the young, infectable, growth and the inconvenience of keeping the powder dry under field conditions. They have the advantages of not requiring the carriage of large quantities of water as in the case of sprays and of easy and rapid application. But even were methods of application evolved that allowed of a substantial reduction in the labour involved compared to spraying, the cost of dust would itself involve expenditure out of all proportion to the advantages to be gained unless prices are materially reduced.

IV—SPRAYS CONTAINING COPPER

The experiment to determine the optimum strength and interval between applications for a copper spray, Perenox, consisted of six blocks of three plots, each of the latter consisting of four sub-plots, each of 15 bushes. Comparison was made between the effects of intervals between spraying of one week, two weeks and three weeks on the whole plot basis, while the effects of spraying at a rate of approximately 70 gallons per acre with varying concentrations of Perenox were examined on the sub-plot basis. The rate of application was considerably less in the earlier stages of recovery, when the shoots were few and small. The concentrations used were nil, 2 oz., 4 oz. and 6 oz. per ten gallons of water. The experiment was carried out on tea pruned in April 1947 and was continued throughout the South-West Monsoon from budbreak until the bushes were in full plucking. As in the case of the dusting experiment described earlier, primaries were plucked ("tipped") as each formed a bud and two leaves above the pre-determined level of 4½ inches above the pruning level. Leaf blisters were removed and counted over a period of fourteen weeks, while records were also made for a limited period of the number of stem lesions occurring. At the end of the experiment the whole of the "recovery growth" produced by the bushes was removed, and the dry weight of new stems and leaves from each plot recorded. The results are set out in Table V.

The degree of infection of the "control plots" during the period was high, and as the experiment progressed, the amount of young leaf and of buds on the control plots fell behind that on the treated plots. The differences between the total recovery weights of the control series and those of the treated series (Section C, Table V) represent tissues, at one time infectable, absent from the control plots. In other words, by virtue of their continued successful recovery, the treated plots exposed between treatments a greater surface of potentially infectable tissue than the controls. If differences in weight of 'recovery growth' be taken as a rough measure of this difference in potential opportunity, it would appear that had equal infectable surfaces been maintainable on all plots,

TABLE V.

Perenox.—Effects of varying concentration and spraying interval on recovery of tea pruned 12th April, 1947.

Section	Measurement	TREATMENT							
		Interval in weeks	Nil	Weight in 10 gallons water				Spray interval	
				2 oz.	4 oz.	6 oz.	Sig. diff.	Totals	Sig. diff.
A	Total leaf blisters recorded from totals of 90 bushes during 20 weekly collections from 3-5-47 to 13-9-47 inclusive.	1	27,250*	1,922	1,802	939	496	4,663	7,710
		2	34,318*	8,922	9 954	5,917	2,534	24,793	
		3	33,506*	18,298	17,558	16,046	—	51,902	
B	Total stem lesions recorded from totals of 90 bushes during 3 weekly collections from 15-7-47 to 29-7-47 inclusive.	1	456*	21	17	18	—	56	225
		2	406*	122	123	108	—	353	
		3	679*	318	220	193	—	731	
C	Total dry weight of new growth (stems and leaves) present below the plucking table 22 weeks from pruning, in grammes per 90 bushes.	1	4,451*	7,763	7,458	6,718	—	21,939	2,643
		2	3,650*	6,087	7,683	7,422	—	21,192	
		3	3,809	5,653	5,212	5,815	—	16,680	
D	Dry weight of new stems present below the plucking table 22 weeks after pruning, in grammes per 90 bushes.	1	1,474*	2,271	2,017	1,869	—	6,157	Just not significant
		2	1,301*	1,901	2,216	2,171	—	6,288	
		3	1,346	1,847	1,636	1,845	—	5,328	
E	Dry weight of new leaf remaining on the bushes 22 weeks after pruning and after 5 weeks plucking, in grammes per 90 bushes.	1	2,977*	5,492	5,441	4,849	—	15,782	1,880
		2	2,349*	4,186	5,467	5,251	—	14,904	
		3	2,463	3,806	3,576	3,970	—	11,352	
F	Ratio $\frac{\text{New leaf}}{\text{New stem}}$	1	1·99*	2·47	2·72	2·65	—	7·84	0·61
		2	1·80*	2·18	2·46	2·40	0·22	7·04	
		3	1·76*	2·04	2·19	2·18	—	6·41	

NOTE.—The Notes to Table IV apply to Table V also

the controls in the monthly (Table IV) and three weekly (Table V) series would have exhibited significantly greater infections than the treated series. The smaller differences in recovery growth between treated series, excluding controls, here renders this factor of little importance, save in the examination of the effect of variations in the treatment interval to be discussed in Section V.

The interest in the effects of the spraying treatments centres in the questions whether the good control already shown to result from the use of Perenox can be markedly improved upon by the use of higher concentrations, whether the same result is achievable at lower cost by the use of lower concentrations and whether the effects of variations in treatment interval are relatively important.

Study of Sections A and B of Table IV indicates that, provided the spraying interval is small, the effect of increasing the concentration of the spray is also small. In other words, effective control is achievable by weekly spraying with Perenox at the strength of 2 oz. in 10 gallons, and the solitary advantage resulting from the use of 6 oz., *i.e.*, the small reduction in leaf blister, is quite unimportant. Since labour, however, represents the most important item of cost in field spraying with knapsack sprayers, a ruling is desirable as to whether additional strength would compensate for less frequent sprayings. The data for both leaf blisters and stem lesions indicate that substantial loss of control occurs with fortnightly spraying, and that this is by no means compensated for by the effect of using a strength of 6 oz. in 10 gallons. Further, it is apparent from Sections C, D and E that, although fortnightly spraying permits of good recovery, three weekly spraying results in a marked drop in the amount of recovery growth. Although this drop is less in the case of the higher concentration of Perenox, the improvement is insufficient to justify the greater cost. A practical rule would appear to be : "Where protection of tipping growth is desired, spray from budbreak to tipping at the rate of 2 oz. of Perenox in 10 gallons of water at intervals of 7-10 days according to the weather, but never exceeding fourteen days." Where protection of relatively small plants in the nursery is the aim, it is desirable to achieve a much higher degree of protection owing to the damage that can result from a single infection, and more frequent treatment is desirable. Spraying with a concentration of 2 oz. in 10 gallons of water once or twice weekly will provide this.

At elevations below 3,000 feet, where leaf area on the bush during recovery has special importance, the defoliation aspect must be considered. Section F of Table IV indicates that weekly spraying is preferable to fortnightly where avoidance of defoliation is important. In such cases, if the spraying interval exceeds 7 days, the strength used should not be less than 4 oz. in 10 gallons.

Having examined some of the factors effecting the field use of copper sprays, a comparison was made of two commercial compounds available on the Colombo market. The concentration of 2 oz. per 10 gallons was adopted and the opportunity taken to test whether the presence or absence of a fixative (Albolineum 2, sold by Imperial Chemical Industries (India), Ltd., affected the efficiency of the spray. This compound was originally used as recommended at the rate of 0.33 oz. in 10 gallons of spray. In order to ascertain

whether any of the four treatments would permit of an extension of the spraying interval, and thereby of a reduction in treatments costs, each of the four treatments were applied weekly and fortnightly to unplucked shoots growing on bearing tea nineteen months from pruning, during the North-East Monsoon. The mean rate of application was at the rate of fifty gallons per acre. The results obtained per unit of sixty-four bushes over a period of seven weeks are shown in Table VI.

TABLE VI

	Weekly		Fortnightly	
	Alone	With Albolineum	Alone	With Albolineum
Perenox ...	743	1,087	2,626	2327
Sandoz ...	695	983	2,074	2008

Over the same period the blisters in untreated plots amounted to a total of 7,558 per unit.

These results are to be regarded as interim findings. The evidence is that the effect of varying the spray compound was not significant, while under the conditions experienced in October-December, 1947, Albolineum at the concentration used had no effect. The makers have now issued recommendations for the use of a considerably enhanced strength (1.5 oz. per 10 gallons of spray fluid), and the experiment is being continued using the latter concentration.

V—TREATMENT INTERVAL

Inefficient protection of the vulnerable tissues may result firstly from inefficient spray application or coverage, secondly from loss of the protective film by rain action between sprayings or before the underlying tissues have become resistant, thirdly, from extension of originally immature tissues to such a degree that the original protective film is no longer effective, and fourthly from the exposure of new, unprotected, and enlarging surfaces following upon the production of additional leaves and internodes by the bud. Compensating to some extent for these factors, there is the rapidly increasing resistance that the tissues acquire as they mature in time and in morphological development through the stages of bud-leaf, first leaf, second leaf, etc., until in the third and fourth leaf liability to infection is quite small. The totals in Sections A of Tables IV and V express the resultant of all these factors. The importance of the treatment interval in affecting the nett result is obvious from the data in the last columns of Tables IV and V.

The interplay of treatment interval and degree of infection is most easily examined in those cases where there is little doubt of the efficiency of the spray treatment when applied, and where the treatment interval is not so great as to lead to material reduction in the amount of recovery growth and, therefore, of infectable surface. The following discussion is confined to the results of spraying with Perenox during the South-West Monsoon, when liability to infection was high. The ratio of *additional* infection in the plots sprayed fortnightly to that in the plots sprayed weekly in the various experiments described was as follows :—

Strength	Ratio
4 oz. in 10 gallons	1:3.4
4 „ „ „ „	1:4.1
6 „ „ „ „	1:5.3
4 „ „ „ „	1:4.5
2 „ „ „ „	1:3.6
Mean	1:4.18

It is known (Bulletin 19, pp. 51-53, 1938) that on the average a leaf unfolds every 6.3 days from the bud of an actively growing shoot. Two leaves are unfolded on the average every 13.1 days; here, for convenience, an average period of 6.5 days per leaf will be assumed. Further, the ratio of surface areas in shoots where a further leaf will shortly unfold from the bud is in the neighbourhood of :—

Bud :	First leaf	Second leaf
1	8	20

Thus in about 6.5 days the tiny leaf curled round the bud expands to about 8 times its size, and in turn expands, another 2½ times in the next period. If a large number of shoots, in all stages of development, are sprayed on a given day, buds and unfolded leaves will acquire a protective film. Each day thereafter some buds will unfold, and unprotected surfaces, themselves extending in area, will be exposed to infection. Using for convenience the figures already given, and measuring leaf areas in terms of the bud area, the following argument can be developed to obtain an explanation of the size of the increase in infection resulting from longer treatment intervals. A bud just after a leaf has unfolded from it is taken to have a size of 0.3 and the mature bud just before another leaf is due to unfold from it a size of 1.0. Using the ratio of areas referred to above, allowing for the increases in average size of the leaves during the relevant periods, and considering an average shoot unfolding 3.25 days after spraying, in the last 3.75 days of the week following spraying the mean relative size over the period of the newly exposed, unprotected bud, will be $0.3+\frac{1}{2}\frac{(3.75)}{6.5}0.7=0.50$, if a linear rate of development is assumed. The small leaf unfolded from it and 3.75 days old at the end of the week will have an average relative size during the period of $1+\frac{1}{2}\frac{(3.75)}{6.5}7=3.00$. The product of the average area multiplied by the exposure time of the unprotected tissues until they are again protected seven days after the initial spraying is thus $3.50\times3.75=13.125$.

If spraying takes place once more after a lapse of seven days from the initial treatment the risk of infection is immediately greatly reduced by the deposition of a protective film over the surfaces under discussion, only to rise once more during the succeeding week. Thus 13.125 may be used to express the weekly exposure of the average shoot. But if instead of weekly treatment fortnight spraying is the rule additional exposure occurs during the second week of the fortnight after each spraying. This additional exposure is increased by the further expansion of the bud and leaf already discussed and by the unfolding of yet another leaf from the bud $3.25+6.5=9.75$ days after the first spraying. The areas exposed over the period may be approximated to as follows :—

(a) Until the bud unfolds a further leaf at 9.75 days after the first spraying, the mean relative size of the bud over the period 7 to 9.75 days is $0.7+\frac{0.3}{2}=0.85$ and of the leaf $5.0+\frac{3.0}{2}=6.50$. The exposure is $6.5-3.75$ days $=2.75$ days.

(b) Between 9.75 days and 14 days after the initial spraying the mean size of the bud over the period drops to $0.3+\frac{1}{2}\ \frac{(4.25)}{6.5}\ 0.7=0.53$ as a result of a new leaf unfolding which grows to a mean relative size over the period of $1+\frac{1}{2}\ \frac{(4{\cdot}25)}{6.5}\ 7=3.29$ while the now second leaf increases to a mean size of $8+\frac{1}{2}\ \frac{(4.25)}{6.5}\ 12=11.92$.

On this basis, the total product of average unprotected area multiplied by exposure time during the second week is $2.75(0.85+6.50)+4.25(0.53+3.29+11.92)=87.108$ The ratio of 'opportunity' in the first week to that in the second week thus becomes 13.125:87.108=1:6.63. As is to be expected, since no allowance has been made for the reduction in the susceptibility of the ageing and developing tissues, this value is higher than the observed mean ratio of infection in first and second week of 1:4.18.

A correction for varying susceptibility requires some measure of susceptibility. It is of considerable interest that the mean rate of germination on leaves of differing morphological status have been found, in laboratory experiments, to bear the ratios to one another of :—

Bud	First leaf	Second leaf
1	0.50	0.11

Applying these values as "susceptibility factors" by multiplying the areas used in the above calculations by them, the opportunity ratio becomes as :—

$3.75\ (0.50+0.50\times3.00):\ 2.75(0.85+0.50\times6.50)+4.25(0.53+0.50\times3.29+0.11\times11.92)$, *i.e.*, as 1:4.01.

This value is very close to that of 1:4.18 observed in the field. Thus it is possible, by relating leaf development rates, areas of unprotected surface, time of exposure, and spore germination rates to obtain a calculated value for the infection ratio which agrees closely, considering the number of approximations and assumptions involved, with the average effects observed in a number of field experiments. The lower increase in infection resulting from fortnightly compared with weekly, spraying of unplucked shoots growing on tea eighteen months from pruning during the North-East Monsoon is interesting and, if confirmed, may indicate more rapid increase in resistance of the young tissues under warmer and drier conditions.

VI ESTATE PRACTICE

It is apparent from the foregoing sections that blister blight can be adequately controlled in the field even under monsoon conditions by dusting, and especially by spraying, provided the treatment interval is sufficiently short. The extent to which such treatments are adopted in practice depends upon cost, which in turn is closely associated with the conditions in which tea is grown in Ceylon while in the case of bearing tea the risk of taint must be borne in mind. It is convenient to discuss estate practice under the separate headings of tea in plucking, of young clearings, pruned tea and nurseries, noting in passing the amendments to the costs given in the *Tea Quarterly*, Vol. XIX Pt. II, page 38, July 1947.

In the case of tea in plucking, no risk of adverse effects upon the manufactured product can be entertained. But even were a compound available that was entirely above suspicion in this respect, the cost of regular protection would normally be prohibitive using existing methods.

Young clearings containing seedling plants present an entirely different problem. The contour planting of modern clearings greatly facilitates protective treatment while the amount of fluid required is small. In consequence, the cost of spraying may amount only to about 75 cents per acre per

treatment. Spraying should be repeated approximately weekly, using Perenox or Sandoz at the rate of 2 oz. per ten gallons. When spraying seedlings it is very desirable to ensure thorough treatment of the young stems as they emerge from the soil. The number of functioning sprayers required will be about one per 10 acres of clearing, allowing for an average total of five days' spraying per week. Spraying should be continued in the intervals of rain, since even a trace of copper remaining on the bud is preferable to allowing it to develop unprotected. In this connection, it may be noted that the only deviation permitted in the spraying experiments described earlier was the postponement to the afternoon or next morning when on the rare occasions that *continuous* heavy rain occurred. Spraying was continued irrespective of light rain, in order that the conclusions reached should refer to the results of field spraying under monsoon conditions.

The cost of protection of clearings of 2-4 years of age will be greater, but should not exceed that of one cooly per acre and half-a-pound of fungicide per treatment, *i.e.*, about Rs. 2. Treatment of such clearings would normally only be necessary in special circumstances, *e.g.*, to allow of a longer period of blister-free growth following centring or pruning than would be provided by the dry season normally experienced in a particular district.

It has already been observed that spraying of pruned tea during recovery should be regarded as a means of commencing pruning earlier than the climatically 'safe time,' but not of continuing it later. Spraying with knapsack sprayers of mature pruned tea on steep slopes has been carried out at less than 2 coolies an acre, the amount of fluid required varying from 30 to 60 gallons per acre according to the amount of new growth. A cost in the neighbourhood of Rs. 3 per acre is thus involved for labour and spray material. Previously, spraying costs have been considered on the basis that spraying should pay for itself in profit on crop saved. It has, however, been pointed out that on many estates additional crop obtained by spraying would cost relatively little over and above the money spent on spraying, plucking and manufacture. Where such is the case, spraying pruned tea to facilitate recovery may well prove a very profitable proposition. In passing, however, two warnings must be given. Firstly, spraying is a costly substitute for pruning for "dry weather recovery from budbreak onwards" and secondly, it is unwise to attempt a more ambitious programme than the number of functioning sprayers warrants. At 1½ acres a day, and a total of 5 days' spraying per week, one sprayer will protect 7½ acres. This acreage can be increased by the use of spraying coolies in relays to allow of continuous use of the machines.

As labour ranks so high in the cost of spraying, labour-saving methods of application are of the greatest interest to the Industry. Various motor sprayers have received notice from the agricultural press lately, but none so far fully meet the stringent requirements of the tea crop. It seems likely that manually operated pump or pressure types which permit of movement up and down the rows of tea, and of the application of the spray fluid exactly where it is required, will prove most useful at present. The pump types have certain advantages in practice in the field, but at least one such type is supplied with too coarse a nozzle. It seems very desirable that makers should interest themselves in local requirements, rather than on the sale of machines elaborated for use under far different conditions. Again, a really mobile and efficient power duster might well alter the economic relationship between

dusting and spraying, provided cheaper dusts could also be obtained.

In nurseries, where the object is to prevent any infection whatsoever, and where nursery labour is usually regularly available in any case, it is desirable to spray twice weekly during the period of rapid elongation of the stems after germination, and once weekly thereafter. Spray concentration need not exceed 2-3 oz. of Perenox or Sandoz in 10 gallons of water while a mulch of powdered dried fern refuse, or tea fibre, etc., placed over the ground and replaced periodically will retain any excess of spray fluid. In this connection, it may be noted, that the finer the spray jet the greater the economy of fluid and the less the risk of adding large quantities of copper to the soil. Robust "pressure chamber" types of miniature flit gun, such as the "Maney" (Colombo Commercial Co., Ltd.), may be used. It is desirable to spray the lines of the seedlings from both sides when the basal stem is young, in order to ensure complete protection.

The data quoted earlier provide some indication of the very considerable labour involved in the investigations discussed, and in this connection it is pleasant to record the invaluable assistance received from Messrs. C. A. Loos, D. J. W. Ranaweera and F. H. Kehl, without which they could not have been completed.

BLISTER BLIGHT IN RELATION TO PLANTING AND SUPPLYING TEA*

BY D. S. CAMERON

(*Reprinted from "The Times of Ceylon" and "Ceylon Daily News" by courtesy of the Editors*)

With the advent of Blister Blight, planting new clearings and the very important work of supplying in old tea — never a simple matter — has now become much more complicated and difficult over a large area of the S. W. districts lying above 2,000 feet for the following reasons :—

(1) Seed-at-stake — an inexpensive and efficient method of supplying in most districts and on most estates — has now become a thing of the past as the tender young seedlings are attacked by Blister Blight and killed off as soon as they appear above ground.

(2) Ball plants (seedlings with a ball of earth) too are just as vulnerable as seed-at-stake and also must be ruled out.

(3) Pencil thick stumped plants are very vulnerable to repeated defoliations by Blister Blight when recovering from stumping.

They might, of course, be stumped in the nursery and sprayed with "Perenox" while recovering. In the opinion of the writer, recovery in a crowded nursery with fierce root competition, is not likely to be as good as it should be and is not recommended.

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* The Institute does not necessarily endorse the views expressed in papers from contributors other than members of the staff.

(4) Basket plants are suitable if grown to a height of 15 to 18 inches, at which size they have a sufficient length of brown wood with old foliage to ensure resistance to, and recovery from, Blister Blight when the tender young top section is attacked and dies back. Old foliage should not be removed.
The objection to baskets, however, is that by the time the plant is 15 to 18 inches high the basket is usually too rotten to be moved to the field without disintegrating. There are other disadvantages to the basket, *e.g.* One's suppliers sometimes fail one and during periods of congestion the railway very rightly gives more important goods priority.

(5) In the writer's opinion the best method of all is to plant the tea seeds at 6 inches by 6 inches and use the Hersall Transplanter which he has found, after many years' experience of it, to be the most satisfactory method of all for supplying tea or planting new clearings.

The above methods deal with plants grown from tea seed which means that weekly sprayings with "Perenox" or "Bordeaux" have to be done in the nurseries if the plants are to be protected from Blister until large enough to go out into the field, and when planted out they are still liable to continuous attack, owing to which development will be greatly delayed and they will be long in coming to the bearing stage.

Supplying by means of tea plants grown from seed should now be regarded in the S. W. districts as merely an interim method to carry us on until such time as a sufficient number of plants for supplying and planting can be grown from internode cuttings taken from mother bushes *Immune* to Blister Blight.

It is probable that most estates have these immune bushes.

The best way to quickly find a number of immune bushes is to offer a generous reward—say Rs. 5—for every immune bush found.

The best stage in which to find the immune bush is in fields 6 to 12 months after pruning.

When found the bushes should be fenced round with "Warratchies" (Gliricidia does very well) and put under a month or two's observation during wet weather.

The wily ones will try to claim the reward by clearing a partially immune bush of all leaves and stalks attacked by Blister Blight—hence the need for fencing and a month or two's observation before paying the reward.

We have here a few beds of internode cuttings taken from mother bushes which have remained 100 per cent immune from Blister for many months past, and which are growing satisfactorily so far, without the protection of spraying.

The technique of growing internode tea cuttings has been frequently described in the *Tea Quarterly* — the Journal of the Tea Research Institute of Ceylon — so that it is unnecessary or should be for me to do so here. The T. R. I. and others have proved that high yielding clones can be brought to the bearing stage without difficulty.

It will suffice if I recommend that beds be deep — to encourage good rooting — that soil be good and well drained, and that the

internode cuttings be handled with great care so as to prevent bruising and fractures of the leaves which allow moulds and other fungi to gain entry.

The cuttings should be spaced 6 inches by 6 inches to permit of the plants being easily lifted by the Hersall Transplanter.

I would remind prospective growers that the first step is to test each mother bush for fermentation, by withering and handrolling a small sample of leaf. If it does not ferment normally it should be discarded as a mother bush.

Obviously there would be little point in selecting an immune bush merely because it was immune — it should be a good yielder in addition.

Doubt has been expressed by some as to the practicability of supplying old tea or planting new areas with plants grown from internode cuttings from mother bushes immune to Blister Blight — owing to the time factor involved.

Twelve high-yielding bushes here allowed to run up unplucked, in order to produce internode cuttings, gave an average yield of 211 cuttings per bush at one harvest of cuttings. It should be possible to get three harvests of cuttings per annum or say in round figures 600 cuttings per bush per annum (One immune bush here yielded 1,087 cuttings at one harvest).

To be on the safe side let us assume that only 400 cuttings per bush will be available per annum from a unit of say 10 immune bushes, and let us see what the potential production of immune planting material will be in say 7 years — 1948-1954.

10 immune bushes by 400 cuttings per annum	...	4,000
@ 80% successes	...	3,200

The internode cuttings will require to be in the nurseries 18 to 24 months before they are fit to plant out in the clearing or multiplication area — to be on the safe side let us say 24 months. That will mean that 3,200 plants will go out in the clearing in 1950, and the same number each year thereafter up to 1954. It is estimated that after the plants have been 2 years in the New Clearing they should be capable of giving 50 internode cuttings each per annum or a total of 160,000 cuttings at 80 per cent successes — 128,000.

Given correct soil conditions in the nursery and carefully selected cuttings 80 per cent of successes can be achieved.

It is suggested that bad jat tea be cut out and used as a multiplication area — planted at 3,500 plants to the acre.

In 1954 the 134,400 plants put out in the New Clearing in 1952 should be capable of yielding 50 internode cuttings each per annum or a total of 6,720,000 @ 80% successes — 5,376,000 plants.

SUMMARY OF POTENTIAL IMMUNE PLANTS IN 7 YEARS

1948	...	3,200
1949	...	3,200
1950	...	6,400
1951	...	6,400
1952	...	134,400
1953	...	262,400
1954	...	5,382,400
Grand Total		5,798,400

At 3,500 plants per acre 5,798,400 plants are sufficient to plant up 1,656 acres of tea. Surely the effort and the time involved in order to overcome the scourge of Blister Blight are worth while?

ISOLATION SEED-BEARER GARDENS

As soon as it is possible to do so — Isolated Tea Seed Bearer Gardens should be established grown from planting material immune from Blister Blight. The State should release suitable land for the purpose.

gramme proceeds. The real "limiting factor" is suitable nursery space, though this could be increased by cutting out existing tea in suitable areas.

The Institute at present envisages the interim goal of the use of resistant clones

STATEMENT

	1948	1949	1950	1951	1952	1953	1954
Cuttings in Nurseries ...	3,200	3.200	3,200	3,200	3 200	3,200	3,200
Planted in N. C. ...			3,200	3,200	3,200	3,200	3,200
From bushes in N.C. @ 2 years old @ 50 cuttings per bush per annum @ 80 % successes ...					128.000	256,000	5,376,000
	3,200	3 200	6.400	6,400	134,400	262,400	5,382,400

Note by Editor :—

The order of priority suggested for selection is firstly, for immunity or high resistance to blister blight infection, secondly, for high apparent yield capacity and good habit, thirdly, for fermentation, fourthly, for ease of rooting, and fifthly, on the basis of more extended observation in the multiplication plots. Of these, the first three can be applied to the mother bush in the field, the fourth to the cuttings from it in the nursery, and the fifth to the clone resulting from the growth of cuttings.

Mr. Cameron's figure of 80 per cent success is feasible provided strict selection for easy rooting is carried out and nursery conditions are favourable. In 1946, the average rooting from 20,248 cuttings of 138 clones was 40.7 per cent. Some of the clones gave nil, some 100 per cent rooting. It is thus probable that only a few of Mr. Cameron's twelve bushes will prove "easy rooters," but this factor is of rapidly decreasing importance as the pro-

for supplying, rather than for replanting to obtain large acreages of tea resistant to blister blight. The latter may well prove practical, however, provided that future conditions allow of such a programme being economically feasible.

Seed gardens composed entirely of resistant bearers are unlikely to result in as high or as uniform a degree of resistance in the progeny as can be obtained from clones, but might well give an increased proportion of resistant seedlings. If the formation of such seed gardens is undertaken, the saving of time achievable by the transplanting of selected mature bushes from the field to the bearer area, or by the budding of existing bearers, should not be ignored. The isolation factor can be over-emphasised. Recent work on contamination of seed crops by "wild" pollen suggests that a *commercial* standard of purity can be relatively easily achieved, although a much higher degree of isolation is necessary to give a negligible expectation of crossing from outside sources.

STUDIES OF SHOT-HOLE BORER OF TEA

III—DAMAGE TO THE TEA BUSH

C. H. GADD

The primary damage to the tea bush caused by shot-hole borers is done during the construction of their galleries in the stems. This of itself would be of little importance were it not for other consequences which result more or less accidentally from the presence of the galleries. The secondary damage may be classed under three headings: (1) Wood-rot, (2) Dieback, and (3) Branch breakage. Of these the last named is the most important as it leads to the greatest loss of crop.

WOOD-ROT

The term wood-rot is used to describe the decayed condition of woody parts of stems brought about mainly by fungi. These fungi as a rule cannot gain access to the wood except through wounds which lay bare a surface of wood, and for this reason wood-rot normally follows pruning. The wounds made by borer beetles, as seen on the surface of stems, are very small. Nevertheless, they provide a means by which fungus spores may come into contact with the wood of infested branches. There is also a suspicion that beetles may carry fungus spores on their bodies when they start the construction of galleries, and should the spores of wood-rotting fungi be amongst them, the risk of wood-rot infection would be materially increased.

The charge against borer beetles, however, is more frequently based on other grounds than these suspicions. The wood of infested branches in the vicinity of galleries is stained reddish or dark purple and the stain is very obvious when the branches are pruned. In Speyer's opinion (1922) [7] this staining is "not serious so far as the upper branches of a bush are concerned, but in the thicker branches and collar which remain after pruning, the stained area decays entirely where the attack has been of long standing." The suggestion here is that the staining is a forerunner of wood-rot.

Decay in thick branches and at the collar is prevalent in bushes which have never been attacked by shot-hole borer, so there must be some doubt that similar decayed areas in infested bushes are the direct consequence of borer invasion. Yet it has been the experience of many planters that, in heavily infested fields, pruned branches showing the characteristic stain at the cut are found to be badly decayed at the next pruning. It should be noted however that the stained branches were pruned, an operation which predisposes bushes to invasion by wood-rotting fungi. Also, when bushes are infested, practically every branch shows the stain at the cut, and unless unstained branches are marked in some way, it is impossible to judge accurately two years later whether the decay is the more severe in those branches which were originally stained.

In order to determine whether there is any direct connection between the stain around borer galleries and the later rotted condition of stained branches after pruning, it is necessary first to consider what causes the stain. Growing on the gallery walls is an ambrosia fungus on which the beetles

feed. That fungus penetrates the wood in the vicinity of the galleries and can normally be recovered from the stained areas (Gadd 1936).[1] When the fungus is isolated and grown in pure culture on agar media, a wine red colouring matter is formed which stains the agar deeply. This stain closely resembles that of the wood around the galleries, and there can be no doubt that the stain in the wood results from the growth of the ambrosia fungus.

The next step is to determine whether the ambrosia fungus causes decay of tea wood. Experiment with the fungus have failed to cause any detectable decay of the wood. Moreover, other fungi isolated from stained wood around borer galleries in unwounded stems have also failed to cause rot of tea wood in controlled experiments (Gadd 1936).[1] These results indicate that neither the ambrosia fungus itself nor other fungi normally carried into the galleries by the beetles are organisms capable of decaying wood.

It should be noted that the wood-rot of borer-stained branches invariably begins after the bushes are pruned, and that no recognisable decay occurs before pruning. This leaves little doubt that the wood-rotting organisms gain entry through the exposed wood surface after pruning or after the branches break. One problem remains. It seems improbable that the invasion and growth of the ambrosia fungus will leave the wood entirely unchanged. Does that change, whether chemical or physical, render the wood liable to more speedy decay when invaded by true wood-rotting organisms ?

An attempt to answer this question (Gadd 1943)[2] was made by measuring the length of wood-rot in infested bushes three years after the branches were pruned. The branches were divided into those having borer galleries in the rotted zone and those without. The galleries in the rotted zone were undoubtedly made before the branches were pruned and it may be assumed that wood around them was stained. One cannot be equally sure however that when no gallery was visible the wood was free from stain, but in general the probability is that the areas containing galleries were more consistently stained than those without galleries. If then invasion by the ambrosia fungus renders the wood liable to more speedy decay, more wood-rot would occur in the areas with galleries than without.

The results from three fields were similar, and in each the rot had progressed furthest in those branches which had borer galleries in the rotting area. It appears therefore that although the ambrosia fungus does not of itself cause wood-rot, invasion by that fungus allows the wood to be reduced more rapidly to a friable condition when invaded by a true wood-rotting organism. This fact is not of serious importance as the difference in rates of decay is not very appreciable. In the writer's opinion, the part played by the borer in causing or accelerating wood-rot is generally over-rated. So long as tea bushes have to be pruned, wood-rot will occur, no matter whether the bushes are infested by borer or not.

DIEBACK

In an earlier article (Gadd 1947)[6] it was shown that the borer beetles exhibit a preference for the node as a place of entry into the stem. The entrance to the gallery is frequently situated just below the base of a bud, and, although the boring usually does not injure the bud itself, it severs the channels along which water must pass to the bud. This injury cannot be repaired.

and it deprives the bud permanetly of sufficient water to cause it to burst. The bud thereby becomes functionless and incapable of further growth. The damage however does not become evident until the bush is pruned.

The pruning of a branch causes the bud nearest the cut to break and the piece of stem above the bud to die. For this reason one of the first rules of pruning to be learned by a young gardener is "Prune to an eye (bud)." By selection of the bud the position of the branch to be grown can be determined, and by making the cut close to the bud the length of the dieback is diminished. Although tea bushes are not pruned with that care the same principles hold good.

If however the uppermost bud, nearest the pruning cut, is incapable of growth owing to the presence of a borer gallery immediately below its base, the next lower bud takes up its function. Obviously the length of the dieback is increased by the length of the internode, the distance between the damaged and undamaged buds. If several successive buds below the cut are similarly damaged the length of the dieback is correspondingly increased. The length of the dieback depends not only upon the number of ineffective buds but also upon the jat of the bush, because high jat bushes have longer internodes. For this reason dieback resulting directly from borer injuries is usually greatest and most noticeable in high jat bushes.

Shot-hole borer however is not the sole cause, nor the commonest cause of dieback in tea bushes. Buds may fail to break for reasons other than the presence of borer galleries, the chief of which is undoubtedly a deficiency of food reserves at the time of pruning. Such a deficiency, particularly when the bushes are clean pruned, may result in the bursting of relatively few buds and the death of whole branches. In bad cases no buds may break and the bush dies in consequence. Unfortunately shot-hole borer is prevalent in many areas where bushes are liable to be deficient of food reserves, and the cause of dieback there is apt to be wrongly diagnosed. Where dieback is due to the borer, a gallery is to be found at the buds which fail to break. The absence of such evidence is indicative that the dieback is due to another cause.

BRANCH BREAKAGE

Borer damage resulting in dieback and wood-rot becomes evident after pruning, but the breaking of branches occurs shortly after the galleries are made. Galleries of certain designs (Gadd 1947)[6] weaken the stems to such an extent that invaded branches are easily broken, at the site of the galleries, by wind and during cultural operations. The loss of branches must result in a reduction in the cropping capacity of the bush, but no satisfactory means has been devised to measure the amount of crop lost. The extent of the loss will be dependent on the number of branches broken, but it will not be directly proportional to that number because of the different times at which breakages occur.

The collection of broken branches from an experimental area, 3.2 acres in extent in the Passara District, weekly after each plucking, was started in 1942 when the bushes were in the second year of the cycle, having been pruned in September 1940. In February the collections averaged 377 per acre per week, and in June they reached a peak of 765 per acre per week. Afterwards the numbers decreased until in February, 1943 they were only 83 per acre per week, and they remained about that level till September when the bushes were

pruned again at the end of a 3-year cycle (Gadd 1944).[3]

The importance of these observations lies in their indication that borer damage falls to an almost insignificant level during the third year from pruning. Like many other borer infested areas this one had previously been pruned on a 2-year cycle, the pruning being done at a time when borer damage was near its maximum. The length of a pruning cycle is dependent upon reasons other than borer infestation, but one can well imagine a planter, after inspecting infested bushes towards the end of the second year, deciding that unless he prunes soon he will have little frame left to prune on to. To what extent decisions of that sort have influenced the length of pruning cycles in infested areas is impossible to say.

The prolongation of the pruning cycle in the experimental area proved successful in every way. The yield in the third year (660 lb. per acre) exceeded the average of the first two years by 60 lb. per acre, and the frames were in better condition for pruning. When the bushes were pruned in September 1943 at the end of a 3-year cycle, the borer damage, and presumably the beetle population, were at their minima ; whereas at the 1940 prune, coming at the end of a 2-year cycle, the damage was near its maximum and the beetle population large. This fact will be referred to later as a possible explanation of a marked reduction in damage during the second 3-year cycle.

Broken branches again began to appear in the plots in May 1944, eight months after pruning, and the weekly average then was only 6 broken branches per acre per week. By the end of the pruning year (September 1944) the number was 108 and by June 1945 it had reached 264 and by July 267 per acre per week. Thereafter the numbers fell as in the previous cycle until the low level of 36 was reached in May, 1946 (Gadd 1945, 1946).[4, 5] These results confirm those previously obtained and demonstrate clearly that borer damage decreased markedly during the third year from pruning. The data do not indicate any likelihood of a further decrease during a fourth year though damage could be expected to remain small.

During this cycle the damage was very much less than in the previous cycle. The peak months, June and July 1945, gave 264 and 267 broken branches per acre per week whereas in the corresponding months in the previous cycle (1942) the numbers were 766 and 703, respectively. As there is no evidence to support the view that the years 1943-6 were less favourable for the borer than the years 1940-3 the suggestion is put forward that the smaller damage in the 1943-6 cycle was due to the smaller population at the beginning of the cycle as already explained ; but further observations will be necessary to establish that point.

Relatively little damage is done during the first year because for the greater part of it the young branches are unsuitable for attack. Speyer (1919) made use of that fact in his scheme for controlling shot-hole borer by pruning at short intervals. His scheme proved neither practicable nor effective, and need not be discussed here.

The records of borer damage during the first part of the 1943-6 cycle in the experimental area are of particular interest as they show that the greatest variation occurs during that period. The experimental area consists of four blocks, one of which (No. 1)

is separated from the others by a distance of about 200 yards. The areas were carefully selected for uniformity for manurial trials, but the records show that although the damage was similar in blocks 2, 3 and 4, which lie side by side, that in block 1 was more extensive and followed a somewhat different course. The records of blocks 2, 3 and 4 are so similar that those of block 2 only are given in Table 1 for comparison with those of block 1.

In blocks 2, 3 and 4 the breakages steadily increased in number from May 1944 till July 1945, but in block 1 the increase was more rapid and a peak (398 per acre per week) was reached as early as October 1944. In that month the blocks were cultivated and manured and because of that extra work the breakages for the month were exceptionally numerous, particularly in block 1, indicating the larger number of infected breakable branches present. The breakages in block 1, as may be seen from the table, fluctuated somewhat between October 1944 till July 1945, near the end of the second year from pruning, when in all blocks they reached similar peaks. At the end of July 1945 11,701 broken branches had been collected from block 1 whereas the totals removed from blocks 2, 3 and 4 were 5,394, 5,129 and 5,926 respectively. (The area of each block is 0.8 acre). The damage was therefore twice as great in block 1 as in the other blocks during that part of the cycle. But after July 1945 and during the third year the damage decreased in all blocks and that in block 1 was no greater than that in the others.

No reason can be offered at present why the damage should have been greater in block 1 nor why it should have reached a maximum there early in the cycle and remained at a high level until the general decrease set in towards the end of the second year. It is evident, however, that although a decrease in damage can be confidently forecast for the third year of a cycle its course during the earlier years is not so certain.

TABLE I

Mean weekly counts of broken branches from two experimental blocks given as breakages per acre.

	1943-4		1944-5		1945-6	
	Block 1	Block 2	Block 1	Block 2	Block 1	Block 2
September	—	—	251	44	205	206
October	—	—	398	62	161	166
November	—	—	224	60	125	122
December	—	—	191	77	122	136
January	—	—	250	115	102	107
February	—	—	250	111	107	97
March	—	—	171	127	82	82
April	—	—	227	154	53	55
May	17	4	284	242	40	36
June	73	15	279	241	47	45
July	185	19	280	261	41	32
August	254	36	215	227	38	35

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THE COMPETITION FACTOR

F. R. TUBBS

Competition between individuals of the same or different species is an ever-present factor in Nature. Thus side by side with the advantages resulting from community of shade tree, tea bush and cover crop there exists competition between them for light, water, nutrients and carbon dioxide. Cultural practice is directed towards maintaining a balance favourable, on the whole, to the tea. But the existence of severe competition between individual tea bushes is accepted. The reason for this is that, generally speaking, a high bush number per acre is associated with high yield. This occurs even though the yield of individual bushes is reduced by competition and is due to the more efficient use of soil resources, the more complete protection of the soil from exposure and erosion, and the greater acreage of plucking surface obtained.

It is only when maintenance of the high bush number per acre is attempted that difficulty arises. The competition of old bushes is perhaps the most serious of the adverse factors in the environment of young supplies, and it is enhanced by close spacing. Though this is commonly recognised, full weight is not always given to its importance nor to possible methods of reducing its severity. The following data illustrate certain aspects of the problem. They are derived from an experiment upon supplying commenced in 1937 and terminated in 1941 owing to the war; the data are, therefore, less complete than might be desired.

The experiment was designed to compare the growth of two-year-old seedlings planted in land from which old tea had been cleared, with the growth of similar seedlings planted amid old tea, with a view to estimating the possibility of drastically increasing the bush number per acre without recourse to replanting.

The comparisons were between :—

(a) Normal replanting — 3 ft. × 4 ft. (3,630 seedlings per planted acre) in cleared plots.

(b) Close replanting — 1½ ft. × 4 ft. (7,260 seedlings per planted acre) in cleared plots.

(c) Interplanting of collar-pruned tea— Along the lines of old tea, which was collar-pruned, (3,630 old

bushes and 3,630 seedlings per planted acre).

(d) Interplanting of clean-pruned tea—As for (c) but with the old tea clean-pruned at 16 inches.

The subsequent growth of the seedlings in the four series of plots affords a measure of the competition experienced from mature bushes pruned with differing severity and also from other seedlings of the same age. Again, the percentage of living seedlings in each year provides a measure of the extent to which competition affected the establishment of the young plants.

The proportion of living seedlings at the end of each of the four years are shown in Table I. The plots were supplied annually during the South-West Monsoon.

TABLE I

Percentage stand of young plants achieved with annual supplying.

Years from planting	Percentage Stand				
	(a) Normal replanting	(b) Close replanting	(c) Interplanting collar-pruned tea	(d) Interplanting clean-pruned tea	Significant difference
1	90.7	90.1	86.5	71.0	6.4
2	95.5	95.1	89.9	78.8	2.9
3	97.0	97.4	91.7	75.5	3.6
4	98.9	98.9	97.5	90.8	1.6

Comparison of the data for treatments (a) and (b) (columns 2 and 3) indicates that competition between stumps planted eighteen inches apart did not become sufficiently severe during the period of observation to adversely affect their establishment relative to stumps planted three feet apart in the row. This was true even of supplies put out in the presence of established seedlings planted two or three years earlier, as is illustrated by the close agreement between the two sets of figures for the third and fourth years.

In contrast to this, stumps planted amid established bushes [treatments (c) and (d) *versus* (a) and (b)] were at once subject to sufficient competition to reduce establishment. The deleterious effect of the presence of the old bushes was, however, affected by their pruning treatment. Thus the young plants showed a markedly better establishment amid collar-pruned bushes than in the presence of clean pruned bushes. In view of this, it is probably safe to attribute the marked improvement in the percentage stand in the (c) and (d) plots in the fourth year to the second pruning of the mature bushes in these series at the end of the third year. That competition increased as the mature clean pruned bushes reached the end of their cycle is indicated by the reduction in stand of young plants from 78.8 per cent to 75.5 per cent in the third year of the cycle. The latter value, though not significantly less than the former, is significantly less than the value to be expected had this series of the plots shown the same average increase in stand in the third year as did the other three series.

As competition may effect the growth of young plants without actually causing death, their growth rates provide more delicate measures of the competition suffered. The growth index chosen was the rate of increase in diameter of the stem at ground level, measurements being made at six-monthly intervals. Unit increase in diameter represents the addition of widely differing amounts of new tissue where stems differ in diameter. The average increase in cross-sectional *area* of the stems every six months has therefore been calculated, the means for each treatment being shown in Table II.

This is the state of affairs that may be assumed to have developed in old tea, since clonal plants have been demonstrated to develop in five years roots of sufficient radius to fully occupy the area of 12 square feet of soil allotted to each plant. The old bushes in the experimental area under discussion may be assumed, therefore, to have developed root systems of as great volume as possible under the local conditions of soil and cultural treatment. It is not surprising, therefore, that the growth of the young plants in both the interplanted series showed the effects of competition relatively early, nor that the accumulated effects led

TABLE II

Growth of stem at ground level.

(Mean increase in cross-sectional area)

Six monthly period from planting	Mean Increase in Square Inches × 100			
	(a) Normal replanting	(b) Close replanting	(c) Interplanting collar-pruned tea	(d) Interplanting clean-pruned tea
1	0.2	0.3	0.3	0.2
2	2.8	2.9	2.8	1.5
3	4.3	4.3	3.3	0.5
4	14.7	13.0	8.7	1.6
5	26.7	21.9	9.0	0.3
6	16.5	13.1	7.8	1.3
7	6.2	11.0	7.5	2.1
Periods 8-18 (Average)	30.1	20.1	6.2	1.1

Considering firstly competition between young plants, it is apparent from the two columns (a) and (b) that its effects were not apparent until the fourth period. Further, its influence thereafter was relatively slight. This was doubtless due to competition between the plants within each row being mitigated by the presence of areas of as yet untapped soil between the rows. Not until the fertile layers of the soil are completely permeated will root competition reach its maximum.

to a very marked reduction in the total growth by the end of the 7th period of observation.

It is again apparent from Table II that the treatment of the mature bushes profoundly influenced the degree of competition to which the young plants were subjected, collar-pruning providing distinctly more favourable conditions for the growth of the young plants. It is again possible to distinguish the effect of the pruning of the mature bushes during the sixth period, the

growth of the young plants showing a distinct improvement relative to that of those in the replanted plots.

mature tea appears to last between six and nine months, while the data shown in Table II suggest that competition from the collar

TABLE III

Annual Growth in thickness at ground level relative to that in the preceding year.

Period	(a) Normal replanting	(b) Close replanting	(c) Interplanted collar-prune	(d) Interplanted clean-prune
4-5	5.8	4.8	2.9	1.0
6-7	0.5	0.7	0.9	1.8

The latter effect is even more marked when relative increases in cross-sectional area are compared, instead of absolute increases. For example, if complete years before and after the pruning in period six are compared in order to eliminate seasonal effects ; the results shown in Table III are obtained. From showing the smallest increase in relative growth, the interplanted series showed the largest after their competitors had been pruned.

The interest of the relatively better growth of the young plants in the interplanted plots compared to that of those in the replanted series in periods 6-7 is enhanced by the fact that they were all centred 2½ inches above the collar at the same time as the mature tea was pruned. This difference in growth occurred in spite of the fact that centring must have prevented full advantage being taken of the period of decreased competition from the mature tea. It suggests the possibility of some form of 'trigger' effect, leading to the utilisation of reserve materials available in the plants whose growth had been checked by competition, but not in freely growing plants.

The reduction in the effects of competition following upon clean pruning of the pruned bushes may not have reached the maximum even after three years. It is difficult to believe that the agency through which competition acts was, under the conditions of the experiment, anything affecting the aerial portions of the bush. Tea tolerates shade and young plants are capable of growth under conditions of far heavier competition for light than occurred in the experiment. Nor is there any reason to suppose the supply of carbon dioxide to have been less in the vicinity of the young plants. One is forced, therefore, to the conclusion that the effects that have been discussed are due to root competition. Such root competition will be for water and for nutrients. The 'trigger' effect postulated above may well be influenced by an increased availability of minerals subsequent to reduction in the severe competition previously experienced from the mature bushes. This would enable the utilisation of the relatively abundant reserves of carbohydrates commonly found in plants starved of minerals.

The experiment provides further evidence in support of the view that pruning, as commonly carried out on estates, materially reduces the absorptive capacity of the roots. The clean pruned mature bushes were

tipped approximately five months after pruning, on both occasions. As root competition was reduced for six to nine months, it would appear that the root activity of pruned bushes had not returned to normal at the time of tipping unless, as is possible, the operation of tipping again checked root activity. The practical application of this point in relation to manuring procedure has long since been emphasised in connection with the results of the Institute's manurial experiments.

Turning to the other practical applications of the information provided by the experiment, the conclusion is unavoidable that it is not feasible to increase drastically the bush number per acre by interplanting existing tea unless the latter were to be collar-pruned, or other drastic measures were taken to reduce root competition. The practice of "isolating" young supplies by severing invading roots is one method of achieving this, but it is suggested that the roots of the mature tea should be severed at a greater distance from the young supply than is commonly the case. One and a half to two feet is probably not excessive. Again, special applications of manure to supplies are frequently made. These will best serve their purpose when applied simultaneously with, or immediately after, the pruning of the old tea, the supplies being left unpruned. A corollary to this is, of course, that if the supplies have to be pruned, it is better to prune them some months before the rest of the field, so that full advantage may be taken of the period of reduced competition from the mature bushes.

THE EFFECTS OF HARD PLUCKING

(WITH SPECIAL REFERENCE TO BLISTER BLIGHT)

T. EDEN

Among the diverse cultural methods that the Institute recommends for the control of Blister Blight the most immediately practicable is resort to hard plucking. Experience has shown that at times of severe attack the third leaf of a flushing shoot is particularly susceptible. Before such a leaf has matured sufficiently to make it relatively immune from attack, there is usually ample time for it to pass through all stages of the disease from invisible infection to the production of a large blister actively disseminating spores. Results obtained so far also show that if the shoot is plucked to the fish-leaf when only two additional leaves and a bud have developed, the number of active blisters is very considerably reduced.

Speaking generally, the tradition of plucking to the fish-leaf is one which has not hitherto commended itself to Ceylon planters ; though in other tea areas, notably Assam, it has long been accepted practice. In 1940 an experiment was started at St. Coombs to determine what effect such a system would have on tea under conditions of climate and pruning cycle noticeably

different from those obtaining in N. E. India. This experiment is still in progress and its results have in many respects been surprising. Until a longer period of survey has been undertaken, the more fundamental aspects of the results cannot be interpreted with certainty, but the data from the first pruning cycle of four years are available and can be considered in relation to the new problem that blister blight has created. As far as up-country areas are concerned, *i.e.*, at elevations above the critical 3,000-3,500 during the limited periods that such treatment is likely to be necessary.

The first noticeable effect of plucking two leaves and a bud to the fish-leaf, in comparison with leaving the third leaf was an immediate increase in yield. This occasioned no surprise, because the time of development of the flush was shorter on fish-leaf plots and more pluckable flushes were produced in a given time even on the same plucking round of nine days. This was subsequently confirmed by a flush count.

TABLE I

Cumulative Yields of Plucking Experiment
Comparison of Fish-leaf and Single-leaf Plucking

Pruned		September 11-12	1940
Tipping	1	January 22	1941
	2	March 7	1941
	3	March 26	1941
Last Round		September 7	1944

Date	Round	Cumulative Yield lb. per acre			% Difference (on single)
		Fish	Single	Difference	
1941 April 22	10	74	66	8	12·1
July 21	20	276	218	58	26·6
October 21	30	610	444	166	37·4
1942 January 17	40	886	702	186	26·5
April 18	50	1346	966	380	39·4
July 17	60	1716	1258	458	36·4
October 15	70	2026	1448	578	39·9
1943 January 13	80	2440	1728	712	41·2
April 13	90	2638	1832	806	44·0
July 12	100	2928	1994	934	46·9
October 11	110	3224	2184	1040	47·6
1944 January 7	120	3614	2462	1152	46·8
April 7	130	3978	2726	1252	46·0
July 6	140	4292	2950	1342	45·5
September 7	147	4428	3024	1404	46·4

feet that forms the upper limit of danger from carbohydrate deficiency, the results are definitely reassuring. They suggest that though hard plucking may go against the grain of tradition, it is unlikely to have any harmful effects on the vigour of the tea It was of considerable interest that this superiority in yield persisted throughout the pruning cycle, and that at the end of four years nearly fifty per cent more crop was harvested from the fish-leaf plots than from the normal single-leaf plucking.

The progress of the experiment is shown in Table I where the cumulative yields are set out at intervals of ten pluckings (ninety days) throughout the cycle.

There has always been an opinion that hard plucking reacted adversely on yields during the following two or three months. Such may be the case if, in addition to hard plucking, bad plucking with loss of buds prevails, but this experiment gives no support to the view that so far as yield is considered, hard plucking prejudices future crop. For two years after plucking commenced, the fish-leaf plots continued to gain on the others though at an even decreasing rate, till, during the last eighteen months a stable increment was achieved roundabout 46 per cent.

The second visible effect of hard plucking was a progressive diminution of individual flush size on fish-leaf plots. By the time the field was eighteen months out of pruning, this diminution was very noticeable. To confirm this a sample period of five rounds was chosen and flush counts were taken from all plots. From these and the dry weight yields two data of interest were derived, (1) the weight of the average individual flushes of both types, and (2) the average number of flushes plucked per round. These are given in Table II and show that flush size on fish-leaf plots had diminished by about 30 per cent. The derogatory effect on yield that this had was more than counter-balanced by an increase in number of flush to the extent of 80 per cent. A simple calculation shows that had the fish-leaf flush been of smaller size throughout (which was not the case), the yield from fish-leaf plots would still have been about 26 per cent greater. In actual fact, because the diminution in size was gradual, the excess yield at the period of flush count was about 37 per cent. It may be mentioned here that this reduction in flush size, which gave leaf of rather different type, was accompanied by some falling-off in the quality of the made tea as reported on by the Institute's team of tasters.

TABLE II

Diminution in Flush Size
(Average of 5 rounds).

	Single	Fish
Average Dry weight in mgm. individual flush	112	78
Average No. of plucked shoots per bush	22	40

Rounds 57 to 61. June 20—July 25, 1942.

The superiority in yield and the diminution of flush size suggested that radical changes in the growth processes of the fish-leaf bushes might be taking place. In particular these results raised the question whether, in order to produce higher yields, the bush was drawing on its carbohydrate reserves. Under the system of fish-leaf plucking the area of foliage remained almost static from the time of tipping. Indeed since leaves grow old and drop off, and since new growth from below the plucking table is limited, it appeared at this period that these bushes were less heavily clad with foliage leaf than at tipping time. They were of course very sparsely covered in comparison with the normally plucked bushes. How efficient old foliage leaf is in synthesizing carbohydrate is not known ; by analogy with temperate annual crops, such as the potato, probably not highly so. The doubt recorded above was therefore a real one.

Tests for starch in the roots were accordingly made and were continued at approximately six-monthly intervals for the rest of the cycle. Four sample roots

randomly chosen were taken from each plot, giving 64 roots from each style of plucking. They were stained with iodine which in the presence of starch gives a deep blue-black stain and the intensity was gauged by a scale of marks from 0 to 3. Though this is a crude test, it was judged accurate enough to show the sort of differences that were likely to affect growth. The scores on five different occasions are shown in Table III.

The salient feature of these data is that the differences between fish and single-leaf bushes were unimportant. Only on two occasions, marked with an asterisk, were these differences statistically reliable. Throughout the observations the roots appeared to have abundant starch reserves.

TABLE III

Starch Reserves in Root.

Total points scored (Maximum possible 192)

Months after pruning	Plucking to Fish-leaf	Plucking to Single leaf	Fish-leaf deficiency
26	176	181	- 5
32	165	177	-12
37	176	187	-11*
42	186	188	- 2
48	177	187	-10*

The main effect on signs of virility that fish-leaf plucking produced was, as previously remarked, a great difference in amount of foliage leaf and a very great falling-off in the amount and quality of the pruning wood. This was given quantitative expression by sample-pruning at the end of the cycle, followed by weighments of the foliage leaf picked off the prunings and of the residual woody branches. Table IV gives the yields of the three categories, flush, foliage and pruning wood. When all these are totalled there is revealed a loss in growth on fish-leaf plots amounting to 8,426 lb. of dry matter; about 36 per cent, when compared with the normal plots.

TABLE IV.

Cycle Yields.

lb. per acre.

	Flush	Foliage	Pruning Wood
Fish	4428	1074	9350
Single	3024	2858	17396
Diff.	+1404	-1784	-8046

Summing up these results and relating them to operations during blister blight attack, it is evident that hard plucking has no immediately harmful effect on the bush as regards yield, but just the opposite. Only after prolonged hard treatment do signs of deterioration begin to show. The first is diminution of leaf size, and the second the reduction of pruning wood. At no stage was there any sign of depletion of stored food reserves. After pruning in 1944 the fish-leaf plots were not prejudiced in their recovery and those that, in accordance with an alteration in the scheme of treatment, have been restored to single-leaf plucking, show a ready response and grow good wood.

The indications are that plucking to the fish-leaf does no permanent harm so long as the bush has already built up its canopy of foliage leaf. During two or three months in the year it may be necessary to pluck hard in order to control blister blight. When

:he severity of attack is checked by the :ombined effect of this treatment and mprovement in weather, ordinary plucking :an be recommended.

At mid and low-country elevations the risk of depleting starch reserves is naturally greater than at the elevation of St. Coombs (4,500 feet) but this experiment shows how little foliage leaf is required to keep a bush actively flushing. Whilst therefore greater care will be required at lower elevations, limited periods of hard plucking should be quite innocuous.

REPORT ON A VISIT TO SOUTH INDIA

ROLAND V. NORRIS AND F. R. TUBBS

The Director, Dr. R. V. Norris, and the Plant Physiologist and Acting Mycologist, Dr. F. R. Tubbs, paid a visit to a number of the tea districts of South India in August, 1947. Originally, the intention was to attend, by invitation, meetings of the United Planters' Association of South India to be held at Coonoor on August 11th-13th. The trip was, however, extended to allow of visits to various tea districts in order to gain experience of the methods of tea cultivation prevalent in South India, especially with regard to modifications designed to meet the threat of damage from blister blight.

In a country where individual planting districts are so widely spaced, travelling takes up a disproportionate amount of time but, nevertheless, in addition to attending Committee Meetings of the Tea Section of the United Planters' Association of South India at Coonoor, and a Tea Scientific Conference, etc., visits were made to the tea areas in the Nilgiris (Coonoor), Anamallais, High Range and Nilgiris Wynaad, where the U.P.A.S.I. Tea Experimental Station is located.

A most gratifying personal aspect of the trip was the warmth with which we were received, and the evident desire on the part of senior members of managements as well as individual planters to make themselves acquainted not only with the recommendations of the Tea Research Institute but also with the staff individually. Thus as regards extending the contacts of the Institute the trip proved itself eminently successful. It may here be mentioned that we were fortunate in having informal discussions during the Conferences with the Director of the Tocklai Research Station and the Chairman of the Indian Tea Association and we were accompanied on our tours by either Mr. J. D. Manning, the Scientific Officer of the United Planters' Association of South India or Mr. Wilson Mayne, the Scientific Officer of the Kanan Devan Hills Produce Company, High Range. The warmth and friendliness with which we were met on all sides, the very considerable personal help afforded, and the detailed arrangements made to make the trip as comfortable and interesting as possible, cannot be described. It is, however, particularly desired to acknowledge the help and hospitality received from Mr. J. D. Manning, Mr. W. W. Mayne, Mr. L. E. Mitchell (Secretary, U. P. A. S. I.), Mr. C. F. Clarke (Chairman, Anamallais P. A.), Mr. T. Davenport,

and Messrs. R. Walker and W. S. Mackay of the Kanan Devan Hills Produce Co.

Informal personal discussions were very numerous and, in addition, short addresses on tea manufacture, vegetative propagation of tea and blister blight were delivered to the Tea Section of the U. P. A. S. I., the Anamalais Planters' Association and the Kanan Devan Planters' Association. In each case, a long and interesting discussion followed.

The climates of the tea districts of South India correspond in the main to those of the higher elevations of the South-Western districts of Ceylon. The area of tea receiving the North-East Monsoon only is small compared with Ceylon and is exemplified by estates near Coonoor. Here the climate is very similar to that of Uva and, in consequence, there was very little blister blight seen at the time of our visit, although losses were reported to have been severe during the preceding North-East Monsoon. The climate of individual fields appeared to vary tremendously according to whether their aspect faced straight down to the eastern plains below, or into the hills. Mist and cloud formation was very local in character, and experience here connected mist plus rain with blister blight though a few hours of mist followed by sunshine naturally exerted little harmful influence in encouraging the disease.

The Anamallais and High Range Districts receive a well distributed rainfall and this has been associated with severe attacks of blister blight in the North-East as well as in the South-West Monsoons. Rainfall in the Anamallais varies from about 140 inches per annum, in the eastern areas, to 200-250 inches in the western. In the High Range rainfall progressively decreases across the district to values as low as 40 inches per annum. The elevations of the tea areas vary from 3,500 feet to 6,000 feet.

One of the most striking aspects of the tea districts is the completeness, evenness and density of the Grevillea shade over large areas. In the Coonoor area, the eastern approaches to the Anamallais District, and parts of the eastern half of the Anamallais, the density far exceeded that which would be regarded as advisable in Ceylon. On many estates, the Grevillea was relied on to the exclusion of other types of shade.

In pre-blister blight days this heavy cover was accepted as definitely desirable in conjunction with the prevailing cultivation system, which relied upon shade, plus a persistent and heavy mulch, to compensate for the absence of any system of regular cultivation or manuring. This subject will be briefly reviewed later, after the problems of shade reduction or substitution have been dealt with.

Even though the value of heavy shade be accepted as fully proven under the conditions existing before 1946, there would appear to be no escape from the necessity to modify this practice so as to conform to the changed circumstances resulting from the arrival of blister blight. It seems that the magnitude of the task, and a natural reluctance to embark upon any hasty measures, has led to action being somewhat delayed. At any rate the conclusion was reached that many estates would have considerable difficulty in effecting control of the Grevillea shade without a considerable thinning-out, followed by the use of more easily controlled types of shade tree, and of bush green manures, instead of the pure stand of Grevillea previously popular.

The majority of estates have sought to gain time and experience before embarking

upon drastic action, by pollarding or re-pollarding the Grevilleas without reducing the stand. The luxuriant growth of this tree in many parts of South India has made this an operation of only very limited effectiveness, and it seems likely that a heavy price for the continuance of a heavy stand of Grevillea may have to be paid in the form of labour spent on lopping. Practical difficulties in covering large acreages quickly will prevent shade being maintained in dry weather and speedily reduced on the onset of monsoon conditions.

The problem is no simple one to solve, bound up as it is with the maintenance of mulch so essential to the prevailing system of cultivation. The Grevillea leaf has a high carbon-nitrogen ratio and, with the prunings that lie relatively uncollected (owing to the abundance of other sources of firewood) forms a persistent mulch, very different to the evanescent covering resulting from mulching dadap or gliricidia leaf. A large reduction in Grevillea shade may speed up a change in cultivation methods generally which economic pressure, calling for higher yields per acre, is likely, in any case, to lead to.

The problem of organic material can be met partly by increasing the almost negligible amount of bush green manures that is grown, and partly by the substitution, when necessary, of shade trees more easily controlled. There will, however, be a price to pay for the greater freedom from blister blight thereby obtained. Once again, the need exists to balance, as in Ceylon, the disadvantages of change against its advantages. In Ceylon, where damage from blister blight has been relatively light, a type of conservatism appears to be arising which was very little in evidence in South India, where the need for change was, in general, accepted. It is possible that, once shade has been dealt with, South India may suffer less damage than Ceylon from blister blight, owing to the relatively widespread acceptance of limitations upon the time of pruning as compared with Ceylon.

In the Anamallais, in those cases where dadaps were seen in number, one or more branches were allowed to develop freely to provide cuttings. These were frequently very massive, often 2½ inches across and some four feet in length. On these estates shade was arranged as in Ceylon, lines of Grevillea and dadap alternating, though the vigorous growth produced a much heavier shade than would result from similar spacing in Ceylon. The spacing of dadaps varied from 12 feet by 18 feet to 15 feet by 20 feet, three loppings a year being necessary. In the areas worked on this system shade appeared to be now completely under control. The fear of wind damage has, however, naturally emphasised, up to the present, a general preference for heavy Grevillea shade.

In general, successional planting of shade trees has not been adopted with consequent aggravation of the difficulties of thinning or control.

The heaviest shade seen resulted from Grevilleas about 10 feet apart in every fifth row of tea, their boles being about 18 inches in diameter at the base, and the density and amount of their foliage being such as would be regarded as most remarkable in Ceylon.

In parts of the High Range, Spathodea, the Tulip tree, was seen in tea and was lopped as in the case of other species. Marked variations were seen in the density of the shade. On the one hand there was extremely heavy cover designed to check invading grasses introduced by cattle

movement; on the other there were areas with very little shade that appeared very similar to parts of the Nuwara Eliya district. This local variation in shade density was observable in both the eastern dry areas and the western and wetter areas. Complete loss of crop and of *arumbu* from blister blight was observed under a local area of very heavy shade at 5,000 feet. Pollarding of Grevilleas is not as generally adopted as in the Anamallais and Nilgiris while, since the trees do not become stag headed as early as in Ceylon, they are allowed to reach a much greater girth than would be acceptable here. The condition of the Grevilleas deteriorated markedly from east to west across the Anamallais, growth in the wetter areas being more comparable to that in Ceylon.

Allusion has already been made to the heavy mulch observable over the greater part of the tea areas seen. It was fortunate that very heavy daily rainfalls, up to 14 inches in some cases, occurred in the High Range during our visit. In spite of the general absence of drainage systems as understood in Ceylon, the aim being merely to ensure that water from slab rock or roads was led directly to the nearest natural nettykan, the very considerable mulch on the soil, together with the presence of weed growth on what little soil was exposed, and the very good cover of tea and Grevilleas, resulted in surface water running gin-clear even during the heaviest downfalls. It was a most impressive demonstration of the value of mulch. The turbidity that appeared in streams and rivers, even when the latter rose many feet, was slight and would, it appeared, be easily accounted for by roadside slips and wash where raw earth was exposed. Even in some of the drier areas, soil several inches deep in mulch was seen. The only weeding carried out, apart from elimination of grass, was handweeding of the biggest weeds. Weed growth in general was checked by the mulch. The provision of such a mulch would no longer appear to be practicable in Ceylon. Cultivation is only carried out occasionally and to a very restricted degree, manures being normally broadcast on the surface of the mulch. Owing to the cessation of pruning it was not possible to judge to what extent the mulch survived continuously from one cycle to the next. As was to be expected the mulch was generally lighter in the drier areas and the effects of local erosion were noticeable. It would appear that where the thickness of the mulch is insufficient to prevent successful growth of bush green manures, their adoption, as in Ceylon, would be advantageous.

The same general remarks, relative to Ceylon, apply to the Anamallais as to the High Range. In parts of the Anamallais weed growth appeared more luxuriant, but the policy appeared to be to defer weeding, save for grass control, until the drier weather facilitated cheaper work. Weeding is normally carried out about three times a year, the weeds getting rather out of hand during the wetter weather, but nevertheless it is sufficiently controlled to prevent grasses and noxious types from obtaining any serious hold.

Perennial grasses quickly caused ill-effects but the "tufted" annual grasses were apparently, within reason, accepted as "weed growth." The general appearance of the areas was thus novel to Ceylon eyes and the smallness of the exposed soil surface was most striking. Manuring programmes varied from the regular to the spasmodic Probably not more than half of the total tea

in South India is manured at all, applications in the manured areas averaging about 40 lb. of nitrogen and 20 lb. each of phosphoric acid and potash per acre. Fertilisers are scarce and, as no rationing system is in force, distribution is irregular and uncertain.

Comparison with Ceylon's cultivation system is of little value for South India has, so far, by concentrating upon shade, mulch, and soil conservation avoided the necessity for extensive cultivation and manuring at the price of yields which, although moderate, are not low by *average* Ceylon standards. In the High Range, for example, yields averaged about 600 lb. per acre in the past with either no, or extremely irregular, manuring.

If blister blight continues to be severe until shade control is more general, as may be expected, the maintenance of the heavy mulch essential to the permanency of this system may prove more difficult and a slow change to methods more akin to those in Ceylon may occur. As yet, labour is not forced to seek the whole of its firewood in the pruning fields as in Ceylon, and it is unlikely that this will occur in a measurable time. In consequence, the prunings remain to provide stability to the mulch. It is difficult to escape the conclusion that South India provides an object lesson on the slow expenditure of natural resources rather than extravagant consumption.

The pruning generally tended to follow the slope of the soil surface to some extent, departing from the horizontal to the extent of 2-3 inches over the surface of a bush. Tipping is often carried out higher than in Ceylon, especially in the Anamallais, and a further adjustment of slope is then made, the primaries on the upper side of the bush being tipped, if necessary, at a greater height above the pruning cut than normal. Tipping used to be completed about three months after pruning, but there was general acceptance, owing to blister blight, of the need for higher pruning, earlier tipping, and a reduction in the length of tipping primaries so as to reduce the long and vulnerable period of pre-tipping growth. To Ceylon eyes, the high tipping gives a "run-up" appearance in contrast with the "browsed" appearance of our bushes to South Indian eyes.

The generally high jat of the tea has the result that cutting across or 'light' pruning leaves fewer points on the pruned bush than is the case with our more freely branching hybrid types. This, in combination with the high tipping, sometimes results in a slower 'filling up' of the new plucking table.

The slope plucking, together with the generally high jat of the tea, combine to give a most impressive appearance of control and of uniformity. A flat table is maintained as long as possible, but a domed surface becomes evident in the 3rd and 4th years.

Spacing of tea varied from 3½ by 3½ feet upwards. There is little or no closely planted tea but it is commonly accepted that wider spacings than 3½ feet have led to soil deterioration and lower yields. Contour planting has received no attention but the need to spray new clearings may now enforce this.

BLISTER BLIGHT

In view of the relatively large research man power available in Ceylon compared with with South India, and the frequent interchange of information between the scientific officers of the respective research organisations that has gone on ever since the disease arrived in the two countries, it

is only natural that the main results of the trip should have lain in the extension of our field knowledge of the disease. In this connection the importance may be stressed of maintaining sufficient research personnel to allow, not only of the recording and analysis of plantation experience, but also of local experiments carried out with the critical and unbiassed approach for which scientists are presumably employed. The South Indian Tea Research Station now has a staff of one Senior and one Junior member only, with no Mycologist. The present policy of the Tea Scientific Section is therefore necessarily based, in the main, on the assimilation and adaptation of the results of research conducted in other countries.

It is reassuring that the experience gained during the visit has reinforced rather than modified the conclusions already come to in regard to the disease in Ceylon.

Earlier reference has been made to the problem of thinning heavy Grevillea shade, a problem aggravated by the large size of many of the trees. In certain areas pollarding or repollarding has been resorted to in an attempt temporarily to reduce the amount of shade. This, however, results in time in extremely vigorous growth and the production of a dense shade even closer to the tea. Such a policy therefore carries with it the corollary of heavy labour requirements for repeated thinning of the growth of the pollarded trees and, though satisfactory as a stop-gap, would appear less sound from a long range point of view than a planned substitution of trees which can be lopped at lower expense.

There is general caution in adopting close plucking except to 'save crop' during heavy attack. The tendency for pluckers to continue close plucking thereafter, when once the policy has been sanctioned for a limited period, appeared to be under control. This is probably due in part to the fact that close plucking was not adopted for indefinite periods, but only for a stated number of rounds.

High tipping involves the consequence that secondaries from the lower parts of the tipping shoots have to grow considerable distances before they in turn are plucked and produce tertiaries. In weather favourable to blister blight this further prolongs the period elapsing before a dense plucking table is formed, and before the secondaries escape the risk of blister blight damage during the formation of the plucking table.

In South India, as in Ceylon, the question of time of pruning has received considerable attention but a definite policy had not been formulated at the time of our visit. In districts which vary greatly in elevation, differences in time of budbreak after pruning, as in Ceylon, will need to be taken into account. The general approach to the problem is on the same lines as in Ceylon, but the heavy damage done in 1946 to tea pruned in August, September and October has had the subsequent advantage of discouraging the attempts to "beat the gun" sometimes noticeable in Ceylon.

There was unanimous agreement that attempts to control the disease by measures enforced by legislation should be abandoned. It is understood that the legislation at present enforced will lapse at the end of the year. The compact nature of each tea planting district and the very considerable distances separating each, placed South India in a totally different position to Ceylon as regards an attempt to *eradicate* the disease. This led to the radical difference of approach in the early days of the disease, but experience has shown that, even

under their more favourable conditions, control rather than eradication must be the aim. There is now a distinct tendency to concentrate on long term measures such as shade control, adjustment of pruning time, etc., rather than on shorter term measures such as attempts to eliminate the disease from given areas of tea.

In the Anamallais, particularly, blister blight caused considerable loss of crop and damage to young supplies in late 1946 and again during the South-West Monsoon of 1947. Blister blight records in December and January 1947 were higher than in any other district in South India, and *averaged* approximately 3½ on the Ceylon scale. The loss of crop during June-July had been succeeded at the time of our visit by a general 'flush.' Where this had not as yet developed a grey-blue appearance of the fields, due to the absence of the accustomed light green flush, was noticeable.

In the High Range blister blight is progressively less severe as the dry eastern end of the district is approached. The blister blight average was over 3 at the end of 1946, falling to under 1 in March, and rising again with the onset of the South West Monsoon.

It has been stated that losses from blister blight in South India between August 1946 and March 1947 amounted to 4 million pounds. To these must be added the losses incurred in the widespread heavy attacks in June-July 1947. The total annual crop is about 100 million pounds. The second year of blister blight in South India has again been characterised, it is understood, by loss during September and October. The amount of loss seems to be less than that originally feared, but any useful estimate can only be made after an experience of several years and only then, it must be stressed, if other factors such as manuring, etc., remain fairly constant.

In conclusion, it is emphasised that the comments and approach of this report are based entirely upon a 'Ceylon outlook,' a brief visit being obviously inadequate to allow of an adequate suming-up of the local value of the practices described. It seems a great pity that these two tea producing countries have so little contact, and the opinion is stressed that much might be gained by arrangements for Ceylon planters to visit South India. An experience of what, to us, may appear novel approaches to common problems cannot fail to be of ultimate advantage to the industry.

A NOTE ON THE PROPAGATION OF CAMELLIAS

F. R. TUBBS (REVIEW)

The Curator of the Royal Horticultural Society's Gardens at Wisley, England, has recently reviewed some aspects of the cultivation of ornamental species and hybrids belonging to the genus *Camellia*.* His observations, which relate to ornamental species, are of interest in relation to propagation methods for tea (*Camellia sinensis*).

He finds that one of the prime necessities, if success is to be attained in the "comparatively easy" task of propagation, is to choose shoots of the right stage of growth. His description of suitable material strikes a familiar note — "The current year's growth should be taken when the wood is soft yet not of a flopping softness, and the stem of the shoot is beginning to change from the soft green to the brownish shade of the more matured hardening of the stem," Under the seasonal conditions of growth found in England and for propagation under glass, short shoots bearing three leaves and having a "heel" are found suitable. The writer concludes that "given the right shoots there is no reason at all why one hundred per cent should not root." It is interesting that he also refers to the use of single leaves upon a small piece of the parent stem, for which he prefers growth of from six to twelve months age. Older wood of Camellia species, as was found in the case of tea in Ceylon, roots more slowly and more certainly. In Ceylon the single leaf cutting has definite advantages over those formed from short shoots.

The rooting medium used by him consists of a mixture of three parts of silver sand and one part of peat, as was used during the early experiments in the vegetative propagation of tea at St. Coombs. Another experience in common is the ease with which the young roots upon the cutting are broken or damaged by too great pressure being exercised when "firming" the plant into the ground after transplanting.

Experience of the genus as a whole gives a clear indication that its vegetative propagation by cuttings is eminently satisfactory and lends support to our view that tea can be successfully propagated from cuttings on a commercial scale.

* Camellias and their Culture F. Hanger—*Journ Roy Hort Soc. LXXII*, 56-68.

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 26-9-47

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Office of the Planters' Association of Ceylon, Colombo on Friday, 26th September, 1947.

Present.—Mr. R. C. Scott, C.B.E. (Chairman) ; the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.); the Chairman Planters' Association of Ceylon (Mr. W.A. Paterson); the Chairman, Agency Section, Planters' Association of Ceylon (Mr. D. F. Ewen); Messrs. W. H. Attfield, F. Amarasuriya, S. Vytilingam, W. W. A. Phillips and Dr. R. V. Norris (Director and Secretary).

Apologies for absence were received from the Hon'ble the Financial Secretary and Messrs. G. K. Newton and W. H. Gourlay.

1. The Notice convening the Meeting was read.

2. The Minutes of the Meeting of the Board held on the 19th May, 1947, were confirmed subject to a minor verbal correction in the names of those present.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

(a). Reported that Mr. R. Singleton-Salmon, having resigned the office of the Chairman of the Planters' Association of Ceylon, had been succeeded as an ex-officio member by Mr. W. A. Paterson, the new Chairman, with effect from the 21st August.

(b). Reported that Mr. C. A. Meakin had been succeeded as an ex-officio member by Mr. D. F. Ewen, the new Chairman of the Agency Section of the Planters' Association of Ceylon.

The Chairman welcomed Messrs. Paterson and Ewen to the Board and asked the latter to record their thanks to Messrs. Salmon and Meakin for their services to the Institute.

4. FINANCE

(i) *Audited Accounts of the Institute for 1946.*

These had been circulated to members, and the Chairman quoted some of the salient figures. Mr. Scott said the accounts and the Auditors' reports thereon, which were of the usual satisfactory nature, had been considered by the Finance Committee and recommended for adoption.

In regard to insurance, the Chairman said at present the factory and connected buildings were insured at replacement value. Other buildings were however insured at cost value. Although the risk of fire in these buildings was exceedingly low the Finance Committee had recommended that all major buildings, in view of the greatly increased cost of building, should be covered at replacement value. The Board approved this recommendation.

The Chairman also mentioned that a minor adjustment should be made under depreciation, as by inadvertence the T. R. I. car had been depreciated at 10 per cent of its value only instead of 25 per cent. This matter would be adjusted in the 1947 accounts.

The Chairman reported that the interest and capital repayments due on the Government Loan had been met and the outstanding balance of the loan as at 31st December,

1946, was Rs. 428,017. The loan would be extinguished in 1953.

The accounts were then approved on the proposal of Mr. Phillips, seconded by Mr. Paterson.

The Director of Agriculture asked that in future the Auditors' report, and not only the audited accounts, should be issued to all members of the Board, as well as to the Finance Committee. The Chairman agreed to do this.

(ii) *Accounts of the Junior Staff Provident Fund and Medical Fund.*

The above were approved by the Board.

(iii) *T. R. I. Accounts to 31st July, 1947.*

Reported that the cess to the above date was approximately Rs. 10,000 less than to the same date in 1946. This was due to a hold-up in exports due to the harbour strike in June.

The Chairman referred to the profit on St. Coombs estate which at 31st July was Rs. 14,822 with some 64,000 lb. of manufactured tea awaiting sale. In these circumstances it seemed certain the profit for the year would greatly exceed that for any previous year.

In reply to Mr. Phillips, who commented on the food stocks held on the estate, the Director said these were disinfected from time to time and no material loss was anticipated. No difficulty had been experienced in disposing of rycena, but Mr. Daniel's attention would be called to the somewhat high reserves of this food.

The accounts were accepted.

(iv) *Additional Votes.*

The following additional votes were sanctioned after the Director had given details to the Board.

(a) *Estate Working Account.*

Rs. 700 for salary of a Storekeeper-Overseer.

Rs. 1,000 for engine repairs.

Rs. 750 for machinery upkeep.

Rs. 2,100 for cost of resurvey of St. Coombs.

It was decided to refer to the Auditors, the question as to whether this should be debited to working account or to capital expenditure.

(b) *Estate Capital Account.*

Rs. 8,500 for a Direct-fired heater and burner for the E.C.P. drier.

Rs. 5,500 for a new blower.

(c) *Research Revenue Account.*

Vote 32 — Experimental manufacture.—Rs. 1,000 to cover the cost of the patent taken out by the Board.

Vote 39 — Travelling of Staff.—Rs. 1,494 to meet the cost of the visit to South India by the Director and Dr. Tubbs.

(d) *Research Capital Account.*

Water Supply.—Rs. 4,450 for a new pump and motor.

Field Experiments Agricultural Chemist.—Rs. 1,600 for three weighing-in sheds on the experimental plots.

Buildings.—Rs. 75,000 to meet the cost of the three Junior Staff bungalows.

(v) *Government Loan.*

Reported that a payment of Rs. 75,316 due on the Government loan had been duly met on the 25th September. This was made up of Interest Charges Rs. 23,541 and Repayment of Capital Rs. 51,775.

5. AMENDMENTS TO T. R. I. ORDINANCE

Reported that the draft amendments approved by the Board had been duly forwarded to Government and would come up before the new Parliament in due course.

6 FUTURE DEVELOPMENT OF THE INSTITUTE & T. R. I. CESS

The Chairman said he had been going into this matter with the Director. Originally it had been decided to refer this matter to the Experimental Committee. In view of the large amount of detailed work to be carried out, he thought the Experimental Committee was too large for this purpose and he suggested that a Special Committee should be appointed. This Committee would consider in detail the future experimental policy and the consequent requirements of the Institute and Estate in regard to staff, buildings and finance. It would also review the salaries and conditions of service of all grades of the Institute's Staff. The proposals made by the Committee could then be referred to the Experimental Committee for comment before being submitted to the Board.

The Board approved the above proposal and appointed the following Committee to deal with these questions: the Chairman T. R. I.; the Director, T. R. I.; the Chairman, Planters' Association of Ceylon, and Messrs Vytilingam, Phillips and Gourlay.

7. STAFF

(i) *Director.*—The Chairman informed the Board that the Director's present agreement would expire in August, 1948. It was decided that the question should be considered by the Board at the December meeting.

(ii) *Senior Staff.*

Entomologist.—Reported that Dr. C. H. Gadd had proceeded on eight months' leave on the 10th May.

(iii) *Junior and Sub-Staff.*

(a). The Board sanctioned an advance of Rs. 2,000 for the purchase of a car for Mr. W. T. Fonseka of the Passara Sub-Station, this sum to be recovered in monthly instalments of Rs. 50.

The Board asked the Committee appointed under item 6 above to consider generally the question of the provision of cars for those officers whose work involves continuous travelling.

(iv) *Small-Holdings Officer.*

The Chairman said 171 applications had been received for the vacant post and these were being scrutinized. The Board authorised the Chairman and the Director to make the final selection.

8. ST. COOMBS ESTATE

The Visiting Agent's report dated the 30th July had been issued to the Board but the Chairman mentioned that this had not yet been considered by the Experimental Committee.

The Chairman called attention to the revised acreage of the estate as revealed by the recent survery. After allowing for buildings and roads, etc., the acreage of old tea, at 291 acres, was now nine acres less than previously shewn. Yields would in future be based on the revised acreage.

The Director was asked to consider in the Experimental Committee the out-turn of pruners and the work done by these workers.

Favourable comment was made on the figure for made tea per factory labourer and the plucking average.

In reference to weeding, the Director stated that now the new survey had been completed, it was hoped to arrange for family weeding contracts on small plots.

In reply to Mr. Attfield, the Director said a number of bushes had been found on St. Coombs which appeared to be relatively resistant to blister blight. These were being multiplied for more detailed tests.

Reported that the crop figure to the 30th August was 23,400 pounds in excess of the 1946 figure in spite of very unfavourable weather in August.

No serious damage had occurred on the estate during the August floods though falls of 8.40 and 5.31 had occurred on the 14th and 15th.

9. BLISTER BLIGHT

The Chairman reported that the Director and Dr. Tubbs had, in response to an invitation from the United Planters' Association of South India, visited S. Indian tea districts in August to discuss the Blister Blight position.

Dr. Norris said he and Dr. Tubbs had, in addition to attending U. P. A. S. I. meetings in Coonoor, visited the Nilgiris, the High Range and the Anamallais districts. They had also had the opportunity of meeting Mr. Harrison, the Director of the Tocklai Experimental Station, Mr. Manning, the U.P.A.S.I. Scientific Officer, and Mr. Mayne, the Scientific Officer of the Kanan Devan Hills Produce Co. in the High Range, Travancore.

South India had originally hoped to eradicate the disease before it spread throughout the tea areas and legislation had been hurriedly passed to enforce various details of treatment. The idea of eradication had proved quite illusory and it was not proposed to renew the above legislation when it lapsed at he end of 1947.

It might be said that, in general, South India was now following the methods which had been suggested by the T. R. I. to meet Ceylon conditions. Attacks had been severe in South India but the general picture closely resembled that found in Ceylon. Both Dr. Tubbs and himself were satisfied from what they had seen that the measures recommended by the T. R. I. were sound.

Dr. Norris said a short report on the visit would be issued to the Board as soon as possible.

Referring to the Blister Blight position in Ceylon, Dr. Norris said that there had naturally been an increase in attacks following the recent wetter weather. Fortunately the weather had been characterised by breaks of sunny days and these had so far limited the severity of attack where reasonable precautions had been taken. Certain estates which had ignored the Institute's advice and pruned on into the wet weather had certainly suffered severe loss. Generally speaking, however, losses due to Blister Blight had been masked by favourable growing weather.

Correspondence with the Ceylon Association in London in connection with Blister Blight was tabled.

10. MANUFACTURE

The Chairman reported that the application by the Board for a Ceylon patent covering recent work on the manufacture of tea from unwithered leaf had been granted.

11. REPORT OF THE BOARD FOR 1946

The Board approved the draft of the Report prepared by the Director.

12. ANY OTHER BUSINESS

(a). The Board gave formal approval for the fixing of the Seal to Mr. Daniel's agreement.

(b). The Board approved the recommendation of the Finance Sub-Committee

that for the 1948 estimates the cess should be based on exports of 270,000·000 pounds of tea and that the profit on St. Coombs Estate for 1948 should be estimated at Rs. 75,000.

(c). It was decided that the next meeting of the Board should be held at St. Coombs between the 10th and 15th December.

The Meeting then concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS,
Secretary

NOTICES

VISITORS' DAYS

ST. COOMBS

The second and last Wednesdays in each month are Visitors' Days at St. Coombs.

SUB-STATION PASSARA

The second and fourth Thursdays in each month are Visitors' Days at the T. R. I Sub-Station on Gonakelle Estate, Passara.

It is hoped that, as far as possible, visits will be made on these days. Appointments should be made for visits on other occasions.

GUEST HOUSE

The Tea Research Institute Guest House is again available for visitors to the Institute. Applications for accommodation should be sent to the Director, T. R. I., St. Coombs, Talawakelle. Meals cannot be provided unless at least tweny-four hours' notice is given.

The Tea Research Institute of Ceylon

BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. C. Scott, C.B.E. (Chairman).

(2) Mr. H. S. Hurst

(3) Mr. W W. A. Phillips.

(B) Representing the Agency Section, P. A. of Ceylon :—

(4) Mr. J. C. Kelly.

(5) Mr. F. A. Bond.

(6) Mr. W. H. Attfield.

(C) Representing the Low-Country Products' Association :—

(7) Mr. F. Amarasuriya

(D) Representing the Small-Holders :—

(8) Mr. S. Vytilingam

(E) Ex-Officio Members :—

(9) The Hon. the Minister for Finance or his Nominee.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.

(12) The Chairman, Agency Section, Planters' Association of Ceylon.

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

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The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with the *Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle*.

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